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Bituminous Concrete Surface on M-115, Frankfort to Benzonia, Mich.

BITUMINOUS CONCRETE CONSTRUCTION ON SECONDARY ROADS

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TWO years ago the Michigan State Highway Department, with over 9,000 miles of gravel roads in the state trunk line system, and with drastically reduced state finances, was faced with the problem of converting these roads into modern, safe, dustless, smooth-riding, non-skid pavements at a minimum of cost. Construction on the primary roads in Michigan has been with portland cement concrete for many years but the reduction of funds available for construction and the increase in mileage and volume of traffic on the trunk line system has made it mandatory to develop some cheaper types of surfaces for the secondary and tertiary roads which would gain maximum results in serving the traveling public with the small amount of money which we have to spend.

Highway Commissioner Murray D. Van Wagoner saw an opportunity to secure real value in the utilization of the old existing gravel roads and at the same time conserve state funds, and immediately upon assuming office, ordered extensive research work started to develop types of surfacing which would meet the above listed traffic requirements with low construction costs, low maintenance costs, and, of course, must utilize the existing roads and allow the use of local materials.

Classification of Gravel Roads.—The gravel roads on our trunk line system may be classified into two general types:

1. Those roads of nearly primary importance, with large volumes of light traffic, usually constructed to definite plans and specifications, with fair alignment and grades, and sufficient width and thickness of gravel to allow construction of the standard 20-foot surface.
2. Those roads of less importance, usually constructed to lower standards of design, base widths varying from 9 to 12 ft. in width and of varying depths of from 3 to 6 in.

As a result of the experimental work carried on as a

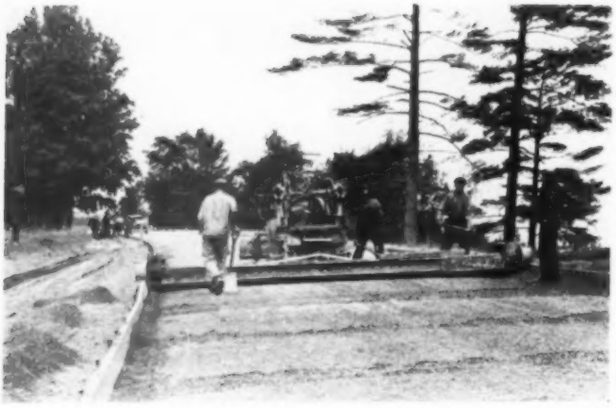

Fig. 1—Reshaping Gravel Base

part of the construction of a number of actual roads during the summers of 1934 and 1935 we have devised and adopted types of surfacing suitable for both of the above conditions, using only the most modern and accurate plant control and placing methods consistent with the class of surface.

1. The higher type for secondary roads is listed in our specifications as bituminous concrete pavement.
2. The lower type for tertiary roads as oil-aggregate pavement.

Details of the Bituminous Concrete.—In this article, because of lack of space, I will attempt to explain in detail only the type of pavement known as bituminous concrete. This type of construction is a plant hot mixed pavement consisting of 1 in. bituminous concrete wearing surface laid on a binder course 2½ in. in thickness on the outside edges tapering to 1½ in. in the center. This pavement is laid 20 ft. in width on a well-compacted gravel base at least 6 in. in thickness after being reshaped to the proper contour and primed with an asphaltic primer, MC-1 type, applied at the rate of ⅓ a gal. per square yard and allowed to thoroughly cure and set before hauling is allowed over the base.

Reshaping Gravel Base.—The necessary reshaping of the gravel base is usually done with a tractor drawn subgrader which runs on steel road forms set in advance to serve as a track for the subgrader. The tops of these forms are set accurately to the grade of the finished pavement, as marked by grade stakes at 25 ft. intervals on both sides of the road. Grades are adjusted by the project engineer in charge to disturb the original gravel as little as possible and to hold to a minimum the amount of material required for the bituminous binder course. At superelevated curves, where the regular road forms are not deep enough to be used on the high side, the gravel is cut down on the low side and built up on the high side by means of a motor grader. Where the depth on the high side is excessive it is built up later with layers of wedge course mixture not over two inches in thickness per layer. The fine grade produced in this way is held to maximum variation of ¼ in. in 10 ft. This feature is very important in the future riding qualities of the finished pavement (Fig. 1).

Fig. 2—Checking Forms with Electrical Surface Tester

After the fine grading is completed, 3½ in. steel side forms are then set to the exact grade of the top of the finished pavement for the mechanical finishing machine which first levels the wedge course where it is necessary, then the binder course, and finally the top course all on the same forms. The forms are checked for variations in grade by an electrical surface tester set for ⅛ in. variation in 10 ft. before and after each course is laid (Fig. 2) and the finished pavement is checked both with a 10 ft. straight edge and the surface tester and any irregularities over ⅛ in. in 10 ft. are rolled out by roller before the mixture is cooled (Fig. 3).

The Bituminous Mixtures.—Sample mixtures for the binder and top courses are shown in Table I. As indicated in this table the top course is designed on the so-called "Skipgrading" principle, omitting stone sizes less than ¼ in., to produce a coarse, skidproof surface texture. The asphalt used is either Native lake or high quality petroleum asphalt of 60 to 70 penetration. The filler material is either limestone or silica dust, a maximum amount passing the 200 mesh sieve. The coarse material in the binder mixture is either crushed stone with a toughness of 7 or gravel 50 per cent of which must be crushed. The stone in the top must be of similar quality but if gravel is used it must be 100 per cent crushed material, made from stones at least ½ in. larger than the maximum size in the mixture. The sand in both mixtures must be clean, hard and durable and conform to the standard sheet asphalt grading.

Fig. 3—Rolling Out Irregularities

Regulation and Control of Mixtures.—The specifications governing the asphalt plant which manufactures the mixtures have been made very rigid and the plant must conform in every particular before the contractor is allowed to start operation. Many modern plant features are required but I will discuss here only some of the most important from the standpoint of regulation and control of the mixtures which assures a uniform quality in the finished pavement.

TABLE I—BITUMINOUS MIXTURES BY WEIGHT

	Top Mixture		
	Usual Operation	Ideal	Per Cent
Stone, ¾-in. to ½-in.	9-12	10	5-10
Stone, ½-in. to ¼-in.	43-46	45	35-45
Sand	32-35	32.7	35-45
Filler	6- 7	6.5	6-10
Asphalt	5.5- 6	5.8	5- 7

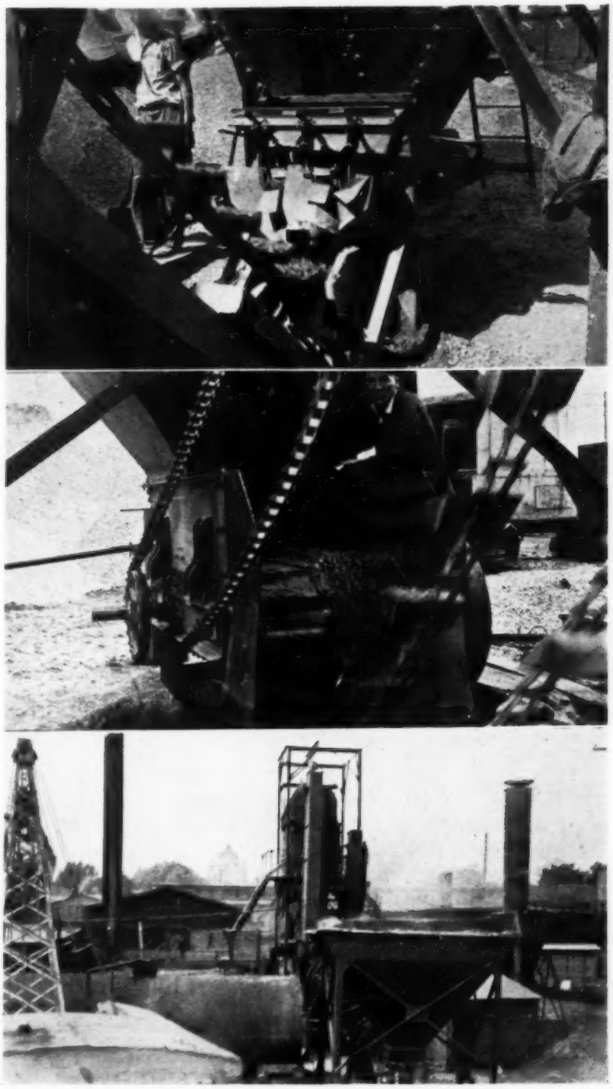

Fig. 4—Asphalt Plant and Details of Feeding Devices

Binder Mixture

	Usual Operation	Ideal	Per Cent
Stone, 1½-in. to ½-in.	50-60	74	30-40
Stone, ½-in. to 10-mesh	14-24	74	30-40
Sand	18-22	21.5	20-30
Asphalt	4.2-4.6	4.5	4-6

Mechanical feeding of the cold sand to the plant elevator is required and where two sands must be blended to secure the proper grading separate bins must be provided for each size and mechanically blended so that a uniform grading may be had at all times (Fig. 4). This feeding device also permits of a uniform feed to the drier and when once set and the burners properly adjusted insures an exceptionally uniform temperature of the aggregate on the mixing platform. This feature helps the contractor in complying with the tolerance of 40 degrees plus or minus in the temperature of the resultant mixtures.

Aggregates and asphalt must be weighed by dial scales, which are equipped with beams and counterpoises to balance the tare weight of the boxes.

Thermometers are required in the asphalt tanks and both a thermoelectric indicating and recording pyrometer for controlling the temperature of the hot aggregate.

The plant must also be equipped with a time-locking device to control mixing operations. This device must lock the aggregate weigh box gate after charging the mixer, until the mixer gate is closed at the end of the cycle. In addition thereto it must lock the asphalt bucket throughout the dry mixing period and the mixer gate throughout the dry and wet mixing periods. The timing device must be encased and after the time interval has been established by the engineer in charge and set by the plant inspector the time lock case is locked by the inspector until a change in mixing period is made.

In the preparation of the binder the dry aggregate is mixed for a period of ten seconds after which the asphalt cement is added and the mixing continued for a period of 35 seconds. For surface mixture the dry mixing period is 20 seconds and the mixing continued after the introduction of the asphalt cement for a period of 60 seconds.

Spreading and Screeding.—Both the binder and wearing surface mixtures are spread by means of mechanical spreaders (Fig. 5) and then screeded by means of a finishing machine of the self-propelled type designed to ride upon metal side forms. Next year we expect to specify that the screed and the propelling device be equipped with separate motors so that the speed of each may be adjusted independently. The screed must be heated to prevent accumulations of the bituminous material. We have found that gas from a tank carried on the machine provides the most satisfactory, uniform, and easily adjustable heating facilities. When placing the top course the screed is raised by means of compression dollies attached to the machine itself (Fig. 6) which allows enough extra material to be placed so that after rolling the finished surface is slightly above the side forms. Compression of both the binder and wearing surface mixtures is obtained by rolling with two 8-ton tandem rollers and one 10-ton 3-wheel or tandem roller. The specifications require that the finished surface after rolling be absolutely true to grade and contour and show no depression or bumps in excess of ⅛ in. as measured with a 10-ft. straight edge paralleling the center line of the pavement.

"Extracted Bitumen Test."—In addition to ordinary tests of materials and mixtures to determine the quality and amount of aggregates and asphalt cement present, the Michigan State Highway Department now makes a recovery test on the bitumen from the pavement itself, after it has been laid and cooled, to determine the loss in penetration and ductility of the asphalt cement. From extensive research work with the extracted bitumen from old pavements throughout the state, we have found that the life of a properly designed asphalt pavement is almost entirely dependent upon the amount of the original penetration and ductility of the asphalt (in a mass) which is retained after being subjected to the heating and mixing (as a film) during the processes

Fig. 5—Spreading Bituminous Mixture with Mechanical Spreader

of manufacture, hauling, and laying of the mixture. This new test called the "Extracted Bitumen Test" was conceived and developed by the writer last winter using the extraction method of Gene Abson and the laboratory procedure for the test was perfected by J. W. Kushing, head of the Division of Research and Testing. This test received approval of the U. S. Bureau of Public Roads for this year and entirely fulfills the requirements of a service test for asphalt which is being stressed at this time. Samples of both the top course and the binder course are taken at the beginning and end of each tank car and sent to the laboratory for the recovery test. The Highway Department also intends to make similar tests once each year from each bituminous project in the state to determine the further annual loss in penetration and ductility.

Although we have been constructing this type of pavement for only two seasons, the results to date have been satisfactory. The bituminous concrete surface, constructed with the refinements as described above, is an exceptionally smooth-riding pavement, non-skid in texture, and the aggregate are all available locally in

Fig. 6—Placing Extra Material for Top Course

any part of the state. Maintenance records, of course, are not available in this limited time. We have constructed about 125 miles of this type at an average cost of $15,000 per mile and we believe the surface compares in every way very favorably with our portland cement concrete.

We have laid the oil-aggregate extensively only this season but we are planning the construction of about 500 miles next year. This type has also met all the requirements for its class and at an average cost of $5,000 for a 3 in. 20 ft. pavement gives promise of very extensive use in Michigan.

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New Transportation Maps Chart Facilities in Iowa

A set of large-scale maps showing all details of the existing transportation system in Iowa has been prepared by the Bureau of Public Roads of the U. S. Department of Agriculture in cooperation with the U. S. Geological Survey. The maps are on a scale of 4 miles to the inch and are believed to be the best of the kind yet produced. The set consists of 8 sheets approximately 26 by 36 in., so arranged as to permit binding on the left margin, and shows in color the location and character of practically all transportation arteries such as the federal-aid and state highway systems, important secondary highway connections, air lanes and landing fields, railroads, pipe lines, navigable channels and canals, thus indicating on one map all the transportation facilities in the state.

The type or character of pavement on each federal-aid or state highway as of the date of the maps is shown by appropriate symbol. The maps also show the location of all national and state parks, forests, and recreational areas in general, and the roads leading to them. However, the maps are too large to be used conveniently for touring.

Iowa is the first state for which transportation maps have been prepared. There is no supply for free distribution. Sets of the maps are obtainable only by purchase from the Superintendent of Documents, Washington, D. C., at $1.75 per set.

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President Approves Bridge Construction Program for the Inter-American Highway

President Roosevelt has approved a program of bridge construction work on the route of the Inter-American highway in Central America, the U. S. Bureau of Public Roads, in charge of activities on the highway, announces.

Congress in June, 1934, appropriated $1,000,000 to meet such expenses as the President in his discretion may deem necessary to enable the United States to cooperate with the several governments, members of the Pan-American Union, in connection with survey and construction of the proposed Inter-American Highway. As the initial activity under this program, the Bureau of Public Roads has undertaken a program involving construction of several bridges, the estimated expenditure being $340,000.

The bridges are as follows: Republic of Panama, bridge over the Chiriqui River, approximately 600 ft. long; Honduras, bridge over the Choluteca River, approximately 600 ft. long; Guatemala, bridge over the Tamazulapa River, approximately 300 ft. long. Arrangements for construction of these bridges have been approved by the three republics concerned. Similar offers of cooperation made to other interested governments are still under consideration by appropriate authorities of the respective countries.

Under present plans, the United States will furnish surveys, plans, specifications, and estimates for the bridges, all steel or other fabricated material for the superstructure, mechanical equipment, and transportation of materials and equipment to the site of the work. It also will construct the superstructure, supervise all construction, and furnish all inspection and supervision when needed in connection with getting out materials furnished by the other country.

The other country will furnish all local materials, and the labor and transportation incident thereto, together with rights of way, and labor needed in constructing the foundations and substructures, removing falsework, cleaning up the site, and grading approaches for a distance sufficient to complete the stream crossing and make the structure usable.

The Inter-American highway route traverses Mexico and the republics of Central America, its termini being Nuevo Laredo, Mexico, across the Rio Grande from Laredo, Texas, and Panama City. About half of its entire length of 3,200 miles lies in Mexico, and the rest in the other six countries. A complete reconnaissance survey of the southern half of the route has been made by the Bureau of Public Roads. The bureau is making further surveys, including a location survey for the final section of the road in Panama, leading to the Costa Rican border. The necessary personnel for the new operations has been engaged, and field work has begun on bridge surveys and estimates. Work on the northern part of the highway will be done by the Mexican government.

EXPERIMENTAL STABILIZATION IN OHIO

By J. W. REPPEL
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THE Department of Highways of Ohio, under the immediate direction of Joseph N. Doyle, Division Engineer, Division No. 9, with headquarters at Chillicothe, O., recently conducted an experiment in stabilization of foundation which involved rigid control of proportions, the use of a commercially prepared fireclay binder, the employment of different kinds of salt and the placing of the completed mixtures on a comparatively new grade, which operation is thought might be of interest to other highway engineers.

Stabilized construction, generally speaking, involves the use of a large part of existing road metal and subgrade in conjunction with additional binder soil as a cementing medium. Material control with these methods can only be approximate. Consequently, it was decided to build, by force account operations, what might be designated a "clay concrete slab" 3½ in. in thickness and 20 ft. wide on the existing grade, exercising rigid control of materials and employing special equipment for the road mix operations.

A section of road at Firebrick on State Route 140, State Highway 402, Section I, Lawrence County, was chosen for this work. This project, 0.8 miles long and partly relocation, was graded and built during the summer of 1934, with a slag surface (T-10 Ohio Specifications). Drainage is good, fills have had ample time for additional settlement under traffic, and the slag surfacing material has penetrated the grade to an estimated depth of 1½ in. Some loose slag had been bladed to the sides in windrows, and this material was accurately measured and incorporated in the mix.

Grading of Materials.—The entire job is 0.8 miles long, or 4,224 ft. Since the road was to be experimental, three kinds of salt were used, calcium chloride, calcium magnesium chloride, and rock salt. Two sections of 850 ft. were built with calcium magnesium chloride and rock salt, and the remaining 2,524 ft. were built with calcium chloride. Samples of available materials, crusher run limestone, screened stone, sand, and eight mesh fireclay, were sent to the Laboratory for preliminary analysis and were found to be satisfactory for stabilization work when mixed in proportions of 60.5 per cent limestone, 28.0 per cent sand, and 11.5 per cent clay. Grading of the various materials, with analysis of final mix were as follows:

Fig. 1—Placing Stone with Spreader Box

Fig. 3—Placing Clay with Chip Spreader on Mixed Stone and Sand

Fig. 2—Placing Sand on Stone for Hand Spreading

Fig. 4—Applying Chloride Before Final Mixing

Fig. 5—Applying Salt on Surface

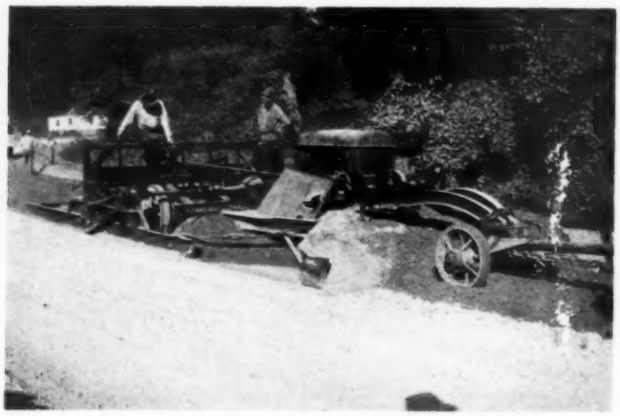

Fig. 7—Mixing Stone, Sand and Clay (Note White Appearance of Clay)

Fig. 6—Mixing Stone and Sand; Windrows Mixed Material Both Sides

Fig. 8—Mixing Stone, Sand and Clay

	Limestone Per Cent Passing	Sand Per Cent Passing	Clay Per Cent Passing	Final Mix Per Cent Passing
1 in.	100			100
¾ in.	98.5			99.0
½ in.	73.3			
⅜ in.	55.2			72.9
No. 4	29.3			57.2
No. 10	9.4	100.0	100.0	45.2
No. 60	2.2	22.6	99.8	
No. 270	1.5	1.6	94.0	11.2
P. Index			16.6	
L. Limit			37.6	

Retread Mixer Used in Placing the Mat.—The 3½-in. mat was placed in two layers of 2 in. and 1½ in. to facilitate placing and mixing, and to insure dense and uniform compaction. As a preliminary operation, the grade was "smoothed up" with a motor grader, and all surface irregularities were removed. The measured loose material in windrows was bladed to the road and placing of the coarse aggregate was started. The mixing equipment used on this project was specially designed and built in the Division Garage for retread work and was very well adapted for the operations involved in this project. It consists of a multiple blade mixing unit, in which has been incorporated a pugmill agitator driven by motor, and an adjustable strike-off unit carried on two parallel forms 20 ft. in length and spaced 10 ft. apart, the latter unit operating independently, vertically, of the mixing unit so that vertical movements of the blades are not transmitted to the strike-off blade. Since the machine used for mixing was designed for one-half width construction, materials were spread to a width of 10 ft.

Fig. 9—Applying Water Before Final Mixing

Fig. 10—Compacting Lower 1½-In. Layer

Fig. 11—Surface After Mixing

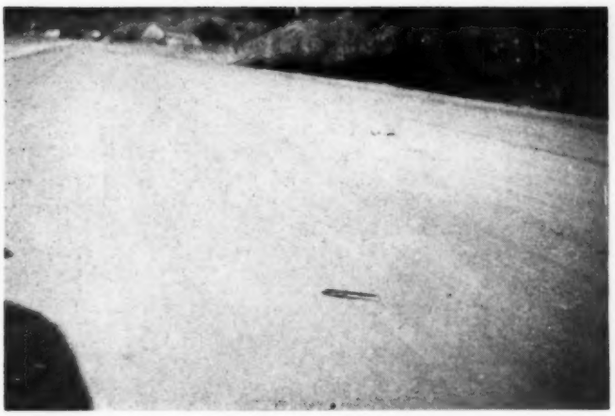

Fig. 13—Completed Surface

Fig. 12—Tire Tracks and Surface Indicate Uniform Mixture and Density

Fig. 14—Completed Surface

Stone was placed at the rate of 127.5 lb. per square yard (for 2-in. mat) through a spreader box attached to truck bed. Sand was then placed on top of stone at the rate of 59.0 lb. per square yard. Several methods of spreading sand were used, and the best results were obtained by depositing material in small piles, evenly spaced, on the stone, and spreading by hand.

An intimate mixture was considered imperative, and the stone and sand were mixed thoroughly by operating the mixer twice over spread materials. Clay was deposited on mixed stone and sand through a chip spreader at the rate of 24.0 lb. per square yard, and the three materials, stone, sand and clay, were again mixed twice. The mixing machine could make one trip (entire length of job) in approximately 15 minutes, and time spent in additional mixing was justified.

The sales were placed on mixed materials through an approved spreader at the following rates per square yard: calcium chloride ¾ lb., calcium magnesium chloride ¾ lb. and rock salt 1 lb. The materials were then given a final mixing and bladed to the side in a windrow easily accessible for rehandling. All materials in the 2-in. layer placed first were mixed dry to facilitate blading operations, and placed in windrows; the remaining 1½-in. layer was mixed wet and rolled on the original base. Materials for the 1½-in. mat were reduced proportionately to those used in the 2-in. mat. The original 2-in. layer was then bladed on the 1½-in. layer, wet down with a distributor, mixed once to level materials, and rolled. This method of placing the two layers presented the best way for least disturbing the materials.

Compacting the Mat with Rollers.—Materials for the first 2-in. mat were placed during a light rain. A heavy driving rain started shortly after the 3½ in. mat was completed, and it was necessary to work the surface for about 2 days with a motor grader to partially dry out the material and maintain a smooth surface. Materials were rolled with 3-ton and 7-ton rollers, and good compaction was obtained. About 3 gal. of water per square yard of completed 3½ in. mat was used; this amount applied before mixing gave the desired consistency for mixing and rolling. As a final operation the surface was screened with a "clay-slag chip" seal treatment. About 5 lbs. of clay per square yard was placed on completed 3½ in. mat, followed by a surface application of 1 lb. per square yard of calcium chloride, calcium magnesium chloride, and salt on their respective sections. Slag chips (100 per cent passing a ⅜ in. screen) were then placed at the rate of 10 lb. per square yard. The

Fig. 15—Close-up Showing Distribution of Aggregates After Core Has Been Removed.

completed surface was thoroughly rolled to key and imbed slag chips as the last operation for the job.

Work was started on Sept. 2nd and completed on Sept. 11th. A total of 919 tons of coarse aggregate, 486 tons of sand, 220 tons of clay, 47 tons of chips, 6.5 tons of calcium chloride, 2.2 tons of calcium magnesium chloride, and 2.6 tons of rock salt were used, at a cost of $2229. Labor costs for the job totaled $925. It must be remembered that an entire new surface course was constructed, with new materials, therefore, the apparent high cost.

Samples cut from the three sections of calcium chloride, calcium magnesium chloride, and rock salt indicated a uniform density and distribution of aggregate—literally "clay concrete"—hard, tough, and wear resistant. The only difference noted in the three samples was a difference in moisture content, the calcium magnesium having the most and rock salt the least moisture. The salt section shows a grayish surface, the other two sections a glazed brown color. At this time of writing, the entire section is tightly bound, non-skid, and hard, with every indication of making a good, durable surface. The writer believes that this type of construction has distinct possibilities as a base for surface treatment or rigid type surfaces, either as a maintenance or contract operation.

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National Paving Brick Association Meets in January

The 30th annual meeting of the National Paving Brick Association will be held at Columbus, O., Jan. 29, 30 and 31, 1936, at the Deshler-Wallick Hotel. Most of the sessions will be open to the general public and those interested in street and highway development are cordially invited to attend.

In addition to the business sessions of the association, the program will consist of papers and discussions by prominent engineer and contractor users of paving brick. Recent important developments in paving brick production and utilization, including descriptions of modern brick street and highway paving and resurfacing projects, will be included. There will be a progress report of the technical study of de-aired paving brick which is being conducted cooperatively by the U. S. Bureau of Public Roads and the National Paving Brick Association. The Research Bureau maintained by the National Paving Brick Association at the Ohio State University Experiment Station will present a resume of its work and an inspection trip will be scheduled to the experimental road recently completed in Hocking County on Ohio Route 31 near Columbus. On this state and federal project eighteen different kinds of fillers, developed in the laboratory of the Research Bureau, have been installed and the results in service will be noted from time to time.

The relationship of brick pavement construction and relaying to unemployment relief and the increasing utilization of brick for resurfacing and reclaiming old pavements and bases will be a prominent feature of the program.

There are forty-one companies holding membership in the Association, fourteen of which have plants manufacturing paving brick in the State of Ohio.

Mr. O. W. Renkert, Metropolitan Paving Brick Company, is president, and George F. Schlesinger, former Director of Highways and Public Works of Ohio, is chief engineer and secretary of the National Paving Brick Association.

Methods of Correcting Slides on Santa Cruz-Los Angeles Highway, California

Slides which occurred on the Santa Cruz-Los Gatos highway near Inspiration Point caused much trouble and expense to the maintenance forces of the California Division of Highways during the past winter and the spring of 1935. How these slides were finally controlled is described in the October issue of California Highways and Public Works.

During the early part of December, 1934, first signs of slide movement appeared in large cracks in the fill slopes. A crew of men were put to work at once sealing these cracks.

The enormous weight of the fill, which was some 45 ft. deep at center line, became saturated by heavy rains and subterranean springs and began moving slowly down the mountain side.

The crew began backfilling the slide portion in the hope of keeping the fill from going out entirely. It soon became apparent that the additional weight only accelerated the slide movement. The road was then closed and traffic detoured over the old road above the fill.

Test holes were drilled in different locations, varying from 20 to 35 ft. in depth, to locate the source of the water which was seeping into the fill. These tests proved water to be present in each of the test holes drilled.

In order to carry off this water a trench was dug on the upper side of the fill by means of a drag line. This trench was dug to a depth of 30 ft. and was 150 ft. in length by 12 ft. in width. This trench was then backfilled with boulders of 6-in. minimum diameter and the water was carried off to an adjacent ravine in which a culvert had been previously placed. A perforated metal culvert was also installed across the road just east of the fill.

These preventive measures were successful in arresting the slide movement. A temporary roadway was then constructed somewhat below grade and 30 ft. wide which accommodated traffic during the vacation season. At that time, however, approximately 50 per cent of the fill had slipped a distance of some 300 ft. down the mountain side.

On Aug. 2, 1935, work was again resumed and by that time the fill had dried out with the exception of one particular spot where further moisture showed up near the toe of the fill. At this point another trench was excavated in a diagonal direction with a 50 H.P. tractor and bulldozer.

The dimensions of this trench were about 30 ft. deep, 12 ft. wide and 200 ft. long and revealed natural solid ground which was treated with liquid asphalt to seal the bottom of the trench. The trench was then backfilled with 6-in. minimum size rock, the rock being placed 6 ft. wide, 10 ft. deep and 150 ft. long.

The rock was covered with a heavy mat of brush and pine boughs. The fill was then brought back to grade by use of a power shovel assisted by two 5-ton trucks as well as a bulldozer. The roadway was surfaced with a seal coat on a 4-inch crusher run base 40 ft. wide.

The fill just east of Inspiration Point slide also caused a good deal of trouble as portions of it slid down the mountain taking with it 40 ft. of 24-in. corrugated metal culvert, thereby cutting off the use of the remaining pipe.

This pipe was replaced at the same time as one at Inspiration Point. In making this replacement the original pipe was discovered 20 ft. under the fill. It was then extended 120 ft. and the trench backfilled with rock, which was likewise covered with a mat of brush and pine boughs.

RECENT RESURFACING IN WINNETKA, ILLINOIS

Methods and Costs on One Item of a Continuous Maintenance Program

By JOHN C. BLACK

Field Editor, Roads and Streets

BETWEEN September 13th and 24th of this year, the village of Winnetka, Illinois, applied a seal coat treatment to 5.42 miles of old pavement with a total area of 67,280 sq. yd. This was done as a step in the continuous maintenance program which was commenced several years ago and is gradually being extended over the entire village. This system not only affords a better average pavement condition than the older method of periodic repairs and patching, but results in substantially reduced costs when averaged over a period of years.

Applying Tarvia with Hose on a Triangular Area

The pavements treated last September included 56,220 sq. yd. of asphaltic concrete laid about 20 years ago, and 11,060 sq. yd. of brick of nearly the same age. Heretofore only patch repairs had been made on these surfaces, the continuous maintenance system having not yet been extended to them. The next treatment probably will be from 5 to 8 years hence.

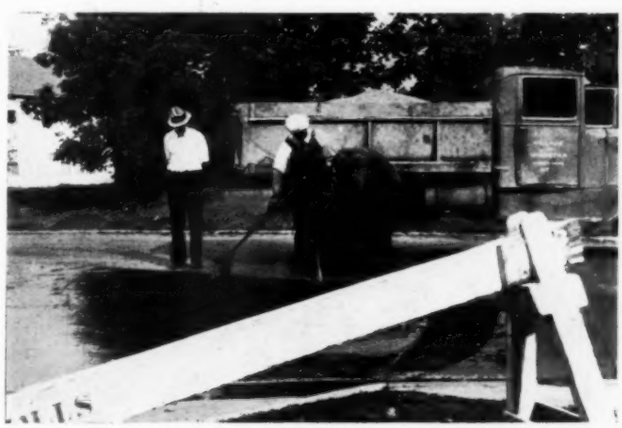
Character of the Treatments.—The recent work consisted in double seal coating the brick pavement, the priming of 44,000 sq. yd. of asphaltic concrete, and the seal coating of the entire 56,220 sq. yd. with Tarvia. Minimum interference with traffic was attained by treating a few blocks at a time and then opening them immediately. In this way the delays seldom exceeded 30 minutes. A week or more sometimes elapsed between first and second treatments.

The Process.—The first step was the cleaning of the surface, which was done with an Elgin sweeper owned by the village. The old asphalt pavement, immediately after cleaning, was treated with a prime coat of Tarvia "B" at a temperature of about 250° F. About 0.25 gallon per square yard was applied at first, but it was found that this was more than would be taken up by the pavement, and that if the excess was left on the surface, it would be likely to cause later bleeding or discoloration. The amount of this application was therefore cut to about 0.15 gallon per square yard, which resulted in an average application of 0.19 gallon. This lighter treatment effectively sealed the cracks in the old surface, and had the advantage of leaving no excess to be picked up and thrown around by traffic.

After the entire width of roadway was coated with tar, a truck containing torpedo sand was backed over it with tail gate slightly open to give an even distribution. The amount of sand so spread averaged 12 lb. per square yard of primed surface.

The sand applications made by parallel truck trips were lapped just enough to insure full coverage. There was no rolling, and the street was immediately opened to traffic.

A few days after the priming, a seal coat of Tarvia



Applying Tarvia by Hand on a Small Diagonal Strip

"A" was applied. One-fourth gallon per square yard was the amount prescribed, but the actual application averaged 0.277 gallon. The temperature in this case also was about 250°. Following the Tarvia "A," pea gravel was spread in the same manner as the sand on the priming coat. The average was 31.8 lb. of gravel per square yard—an amount somewhat in excess of what could be taken up by the tar, but which was used in order to prevent later bleeding.

Following the seal coat the surface was rolled thoroughly with a 6-ton roller.

No primer was used on the brick pavement, but instead it was given two seal coats, each exactly like the seal coat on the asphaltic concrete. The first, as well as the second of these was rolled.

A small crew with brooms and shovels followed each application of sand or gravel, evening up the distribution where necessary, and doing any other hand finishing required.

Triangular patches at intersections of diagonal streets not readily accessible to the distributor were coated with Tarvia and sand or gravel applied by hand. Where the patches were large a hose attached to the distributor and equipped with a regular distributor nozzle was used. For smaller patches the tar was applied with a hand pouring pot. Sand and gravel were spread by shovel on all such places.

Details, Equipment, Crew.—The satisfactory distribution of sand and gravel by truck requires experience and skill in adjusting the width of tail gate opening, driving the truck at correct speed, and maintaining a proper tilt to the body as the contents runs out. One source of trouble in this operation is the presence of an occasional large stone which sticks in the tail gate opening and so leaves an incompletely covered streak on the pavement. When this happens men with shovels cover the streak immediately. It is obviously impossible to stop the truck in the middle of the operation.

Because of the rapid progress of the work and the comparatively short length of each stretch treated, the handling of the barricades was a task requiring the full time of a truck and an extra man helping the driver.

Hot dry weather is most desirable for this class of work. The job here described was completed in a total of six full working days, during which the weather was unseasonably warm.

Equipment

2—Tar truck distributors (rented).
3—4 cu. yd. trucks distributing sand and gravel.
1—8 cu. yd. trucks distributing sand and gravel.
1—Truck following up.
1—Truck moving barricades.
1—Sweeper (part time).
1—Roller.
1—Crane and clam shell (rented) loading trucks from gravel cars on siding.

Crew

2—Tar distributor truck drivers (pay included with distributor rental).
6—Sand and gravel, barricade and follow-up truck drivers.
1—Sweeper operator (part time).
1—Roller operator.
1—Tar distributor operator (pay included with distributor rental).
1—General assistant on tar distributor truck.
2—Men assisting in distribution of sand and gravel.
1—Helper on barricade truck.
1—Crane operator (pay included with crane rental).
1—Man cleaning cars (not paid by village).
4—Follow-up men.
2—Superintendents (cost not included here).

The average rate of pay for skilled and unskilled labor was about 60c per hour.

Cost.—The costs, exclusive of superintendence and overhead, were as follows:

	Prime Coat 44,000 sq. yd.	Seal Coat 78,340 sq yd.	Prime Coat per sq. yd.	Seal Coat per sq. yd.
Tarvia	$1,049.21	$2,656.78	2.39c	3.39c
Torpedo sand	274.05	.....	.62c	....
Pea gravel	.....	1,511.53	....	1.93c
Labor	158.33	388.22	.36c	.50c
Equipment	162.00	394.85	.37c	.51c
Total to end of job	$1,643.59	$4,951.38	3.74c	6.33c
Estimated future costs gravel, etc.)	.....	150.00	....	.19c
Final totals	$1,643.59	$5,101.38	3.74c	6.52c

The cost of the double seal coat on the brick pavement was 13.04c per square yard, and the cost of priming and seal coating the asphalt was 10.26c per square yard.

Tarvia was furnished by the Barrett Co., with an average haul of about 2 miles. The gravel was purchased from Atwood, Davis Co. of Beloit, Wisc., and was hauled about 1 mile from the railway siding.

The entire job was done under the direction of Robert L. Anderson, Superintendent of Public Works.

Four-Yard Truck Spreading Gravel. Note the break in center of the line discharging gravel where a stone has been lodged in the opening

CONCRETE PAVING PRACTICE FOR OREGON STATE HIGHWAYS

By N. M. FINKBINER

Engineer of Materials,
Oregon State Highway Commission

AT the beginning of the automobile era the highway designers and builders were mainly interested in lifting traffic out of the mud of the wet season. Then, forty miles per hour was an exorbitant rate of speed. Automobile manufacturers by continually improving their product thereby raising the speed, made it essential—if traffic is to move safely and expeditiously—that roads be designed and built as "smooth as a billiard table," with plenty of sight distance at curves, and sufficient width to eliminate dangerous congestion.

That there has been a great improvement in the smoothness of our concrete roads is self evident. Oregon originally specified that in any 10 ft. section not more than one-fourth inch variation would be allowed. This was subsequently reduced to one-tenth of an inch and is now placed at seven one-hundredths of an inch per 10 ft. section.

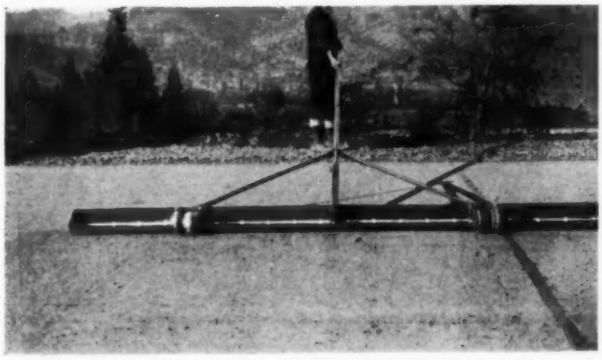
Design.—Standard width is 20 ft. with 9 in. thickness at the outside edges diminishing to 7 in. 3 ft. in. Specified compressive strength is a minimum of 3,300 lb. per square inch at 28 days and is measured by breaking 6 by 12 in. cylinders cast and cured in the field under the same conditions as the pavement.

Expansion joints spaced every 90 ft., are ¾ in. thick, and are set from ¼ in. to 1 in. under the surface of the concrete.

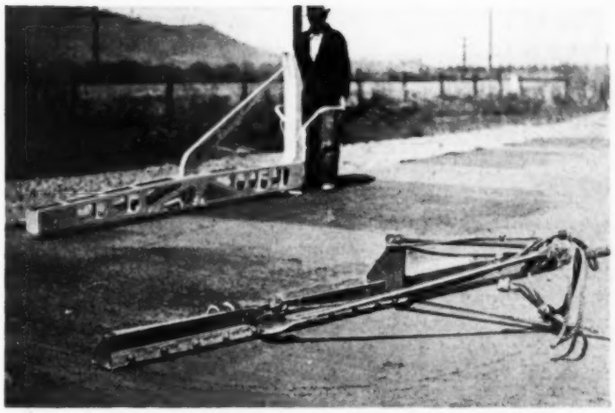
The transverse contraction or "dummy" joints spaced every 15 ft. are ¼ in. by 2 in., and like the expansion joints are set slightly under the surface of the concrete. All joints are kept low so that the floats can work over them with no danger of displacement. They are inserted just behind the spreader.

Dowel bars 24 in. long and ¾ in. in diameter are used at all expansion joints spaced 12 in. apart. They are painted with red lead, then oiled with lubricating oil SAE 50. On one end a 4 to 6 in. sleeve is placed with a stop 2 in. from the end. The same kind of bars are placed 15 in. apart under the "dummy" contraction joints mentioned above, but without the sleeve.

One-half inch deformed square bars 3 ft. long, and spaced every 3 ft., are set transversely along the center line 3½ in. from the surface of the concrete.



Rear View of Planer Float Showing Wheels to Roll Float Back to Center of Pavement



Planometer and Planer Float (in Foreground)

Mix.—Realizing that the unevenness of a concrete road surface is caused largely by unequal shrinkage in the concrete due to differences in moisture content in the various batches, Oregon requires that the water measuring device on the pavers be accurate to within 2 per cent.

Mixes with a slump between zero to 1 in. are designed according to the water cement ratio and fineness factor method of Abrams, with modifications as to maximum density and maximum size worked out in the laboratory.

The laboratory maintains a materials checker at the batching plant to see that the correct weights are used. He frequently tests for per cent water in the fine aggregate and makes the suitable weight corrections. The gradations of the aggregates are periodically checked, and when and if the grading appreciably deviates from that used in setting the mix the job is immediately closed and either a new mix computed or the material difficulty corrected.

Spreading and Compacting.—After the concrete has been deposited on the grade it is tamped and struck off by some standard method, either machine or by hand, according to the required conditions. Machine spreading, however, is the rule.

Rolling.—The rolling is done with a "porcupine" roller which is a light metal roller studded with ½ in. long blunt metal spines. The object of the rolling, of course, is to work as much of the coarse aggregate below the subbase as possible, thus leaving sufficient mortar on top for finishing.

Belting.—The surface of the concrete is transversely and longitudinally belted with a ¾ in. by 8 in. board weighted, when used transversely, to conform to the contour of the pavement.

Floating.—The number of floats—from two to five on a side if 20 ft. pavement is being laid—varies as to con-

ditions of mix, weather, and the rate of paving. In general the number of floats is sufficient to keep the surface in a workable condition during the time of greatest shrinkage.

Several types of adjustable floats are in use at the present time. Any type is suitable which is 10 ft. long, at least 4 in. wide, metal shod and has some provision for truing. These "bull" floats are checked several times a day with 10 ft. aluminum straight edge. Floats generally weigh from 60 to 100 lb.

Since we use a truly delayed finish the last floating is done approximately two hours after the concrete is deposited on the grade. The surface is straight edged subsequent to each floating by the inspector in charge of finishing operations, irregularities marked and then eliminated by further floating.

Edging and Brooming.—All concrete adjacent to both expansion and contraction joints as well as the edges of the pavement are rounded to a ½ in. radius by suitable edging tools.

Brooming is done in the usual manner using rattan brooms drawn transversely along the surface of road.

Preliminary Curing.—Immediately after brooming the surface is covered with burlap and kept wet until the following day; or if one of the flexible film curing methods is used the pavement is sprayed.

Checking and Planing.—From 6 to 20 hours later, depending on weather conditions and rapidity of hardening, the burlap is removed if so covered and the pavement is checked and irregularities marked with a traveling 10 ft. straight edge. This instrument was designed by the Beaver Portland Cement Co. and W. C. Newell who, at the time was an engineer-inspector for the state. As made by the Beaver Co. the straight edge consists of a rigid narrow frame carried by two solid rubber tired wheels set in line just 10 ft. apart. Exactly in the center of the frame is a free traveling hinged wheel with a rigid pointer attached which indicates to the operator in hundredths of an inch the irregularities over which it passes. The pointer can be easily read to one one-hundredths of an inch since its movement is four times the movement of the wheel. Any raise over seven hundredths of an inch is marked by a piece of crayon lowered to the pavement by a flexible shaft controlled by the operator at the handle of the machine.

A scraper designed and built by the same company which makes the "planometer" is then used to plane the high points to at least seven hundredths of an inch. This scraper, generally called a planer or planer float, is made of angle iron, is 10 ft. long and has an adjustable blade of very hard steel.

Final Curing.—After the checking and planting operations are completed, the pavement is covered with earth or sawdust and kept wet for ten days; or if a flexible film curing is used the pavement is again sprayed to cover those sections which were uncovered by planing.

Delayed finish was suggested to us in July, 1932, by the Portland district office of the United States Bureau of Public Roads and the method evolved from that suggestion has given very good results in smooth riding pavement, has lowered impact and minimized the evils resulting therefrom.

▼

Snow Removal Programs Increase—During the winter of 1933-1934 snow was cleared from 188,522 miles of main highways, according to reports of state highway departments to the U. S. Bureau of Public Roads. For the winter of 1924-1925 approximately 62,167 miles were on definite programs, and the total expenditure was $1,795,000. For the winter of 1933-1934 they were $9,397,799.

Leveling Stone in Forms

How to Minimize Stone Displacement in Grouting Cement Bound Macadam

A very simple but effective method of minimizing displacement of stone when distributing grout in building cement bound macadam was introduced in building streets in Glens Falls, N. Y. In general, standard practice was followed in the construction.

Both coarse and fine aggregate were produced locally.

A 9-ton tandem roller was used for initial compaction and a 6-ton roller for final compaction. To protect the ½-in. premolded transverse joints, spaced at 50-ft. intervals, hooded bulkheads of ⅛ by 6 in. steel plate with ¾-in. angles spot-welded to the edge of the plate were used and removed after the roller had completed compaction of the grouted surface.

Grout was mixed in a 2-bag Jaeger mixer equipped with a 12-ft. chute, with 1-in. perforations on 3-in. centers in the last 4 ft. of the chute. Six gallons of water were added to give an estimated content of 8½ gal., which made a grout with a flow of 19 to 21 seconds.

The method adopted to minimize displacement of stone was to place a strip of 1½-in. mesh chicken wire about 6 ft. wide and 10 ft. long on the surface of the stone before grouting, longitudinally under the distributing spout. This permitted working excess grout forward with little disturbance of the surface stone, and greatly facilitated the work.

Neil Havens, Superintendent of Public Works, was in charge of the work.

Placing Chicken Wire Under Distributing Spout

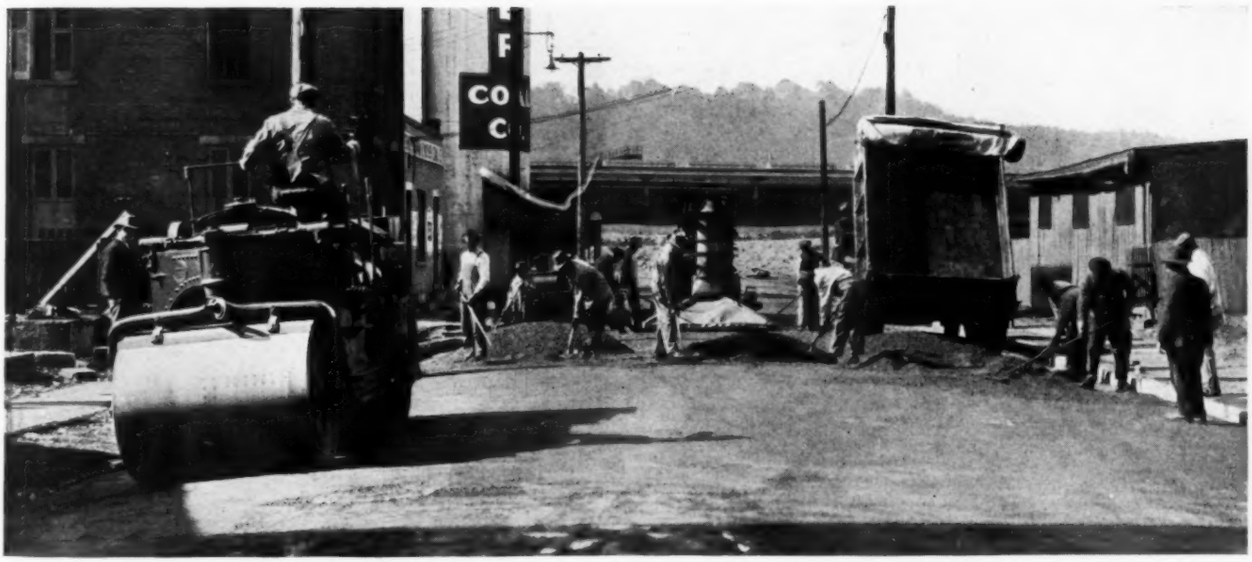


Fig. 1—Surfacing an Old Asphalt Patched Boulder Street with Sheet Asphalt

METHODS AND EQUIPMENT USED IN STREET MAINTENANCE AT CINCINNATI, O.

AN excellent idea of the varied operations and equipment used in the maintenance of streets at Cincinnati, O. was given by H. H. Kranz, Engineer of Highways, in a paper presented Oct. 14 at the 1935 Public Works Congress. The Congress, by the way, was the 41st annual conference of the American Society of Municipal Engineers and the 16th annual conference of the International Association of Public Works Officials. Forty-four slides were shown with Mr. Kranz's paper, in fact the entire paper was built around them. Some of these pictures are printed below together with the descriptive matter from Mr. Kranz's paper referring to them.

Typical Asphalt Maintenance—Resurfacing Poplar St. (*Fig.* 1).—An asphalt paving crew engaged in surfacing an old asphalt patched boulder street with sheet asphalt. All inequalities and defects in the old asphalt surfacing are being burned off by the large superheater in the rear. The sheet asphalt delivered at an average temperature of 350° F. is shoveled into place, carefully raked and luted to grade and then rolled with the 16-ton tandem roller shown at the left.

Typical Asphalt Maintenance—Ninth St. Night Work (*Fig.* 2).—This asphalt paving crew is replacing the worn surface of a sheet asphalt street with sheet asphalt. The excellent light is provided by 4 1,000 candle power electric lights, powered by a portable gasoline engine driven generator.

Superheater in Action—Spring Grove Ave. (*Fig* 3).—This superheater is employed in removing excess asphalt filler from this granite block pavement preparatory to its being resurfaced with sheet asphalt. The heat in this operation is supplied by fuel oil under pressure burning beneath the square hood. In the case of the removal of asphalt patches, the superheater burns away the bitumen binder. The residue which still has some virtues as a paving material is salvaged for use in the repair of boulder streets.

Wood Block Removal—McMillan St. (*Fig.* 4).—Another phase of maintenance is the replacement of old wood block pavement with a stone filler, asphaltic binder and asphalt top. A ½ yd. shovel equipped with a

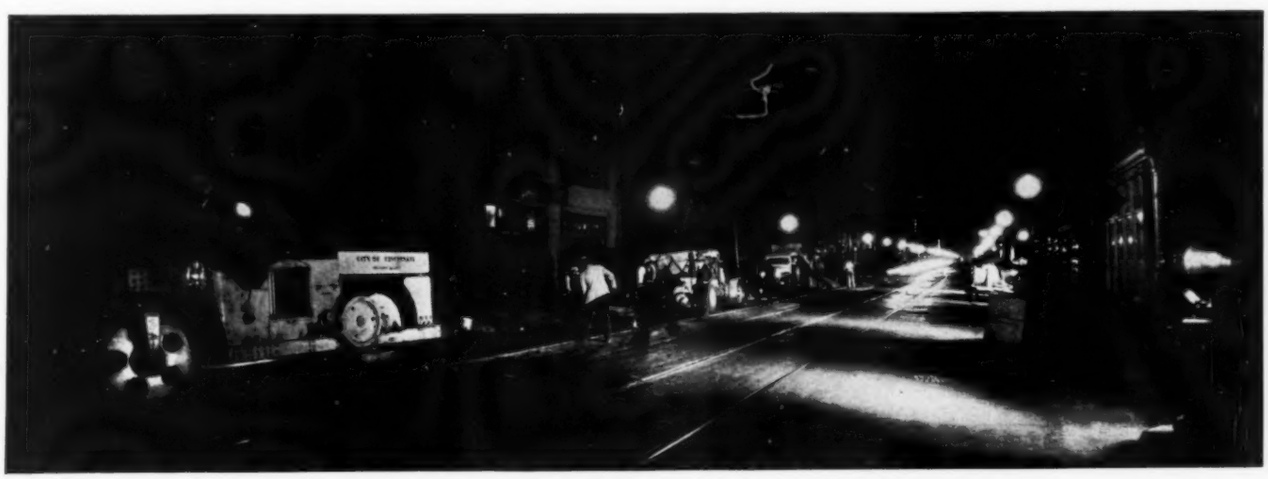


Fig. 2—Night Asphalt Surfacing Work in a Congested District

Fig. 3—Superheater Removing Excess Filler from Granite Block Pavement

skimmer scoop is facilitating the removal of these wood blocks.

Wood Block Pavement Maintenance—Middleton Ave. (*Fig.* 5).—Those wood block pavements which are in good condition are sealed annually with asphalt emulsion to improve their riding surfaces and prevent the infiltration of the surface water. The asphalt emulsion stored in the truck tank is applied by hand pouring cans and squeegeed into place. Sand is applied directly following this operation by hand from the truck in the rear.

Filling Cracks in Concrete Streets—Delta Ave. (*Fig.* 6).—The most important maintenance of concrete streets consists of sealing all cracks before the action of the weather does any damage. This equipment assembled by the city consists of a blower, sand box, and asphalt tank mounted on a truck. The man with air hose and nozzle precedes the filling work and removes the foreign matter from the cracks. The actual crack filling is done by 2-wheeled buggies, each provided with a sand and asphalt compartment. The asphalt flows through a manually controlled orifice in the bottom of the tank while the sand is allowed to run through a second orifice just in the rear of that for the asphalt so that the asphalt is covered with the sand immediately following its application. The buggies are supplied with sand and asphalt from the truck by the laborer shown in the rear so that their operation is continuous. On a good day this crew is able to fill an average of 50,000 lin. ft. of cracks. Note the flagman and "Men Working" sign posted in the interest of safety.

Construction of Cast-in-Place Concrete Markers—Central Parkway (*Fig.* 7).—White concrete markers in asphalt streets are one of the latest solution of the problem of marking traffic lanes, center lines and pedestrian lanes at traffic lights. The asphalt pavement of this street was removed down to the concrete base. These markers are being cast in place, being constructed of white limestone chips, white silica sand and white Portland cement.

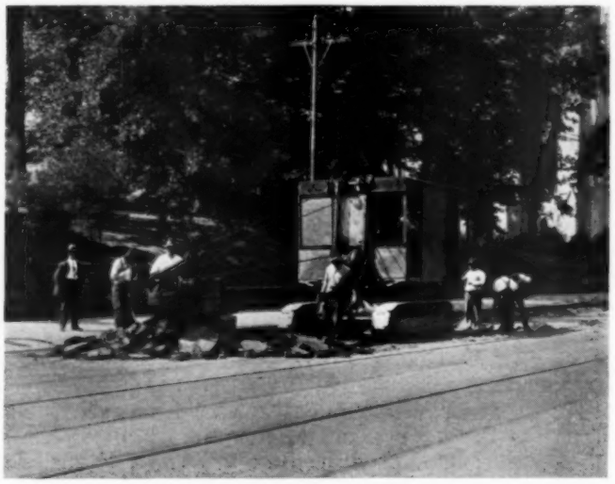


Fig. 4—Removing Old Wood Block Pavement with ½-Yd. Shovel

Installation of Precast Concrete Markers—Central Parkway (*Fig.* 8.)—These precast concrete markers are being installed on a portland cement grout bed, the asphalt pavement of this street having been previously removed down to the concrete base. The chipping ham-

Fig. 5—Sealing Wood Block Pavement with Asphalt Emulsion

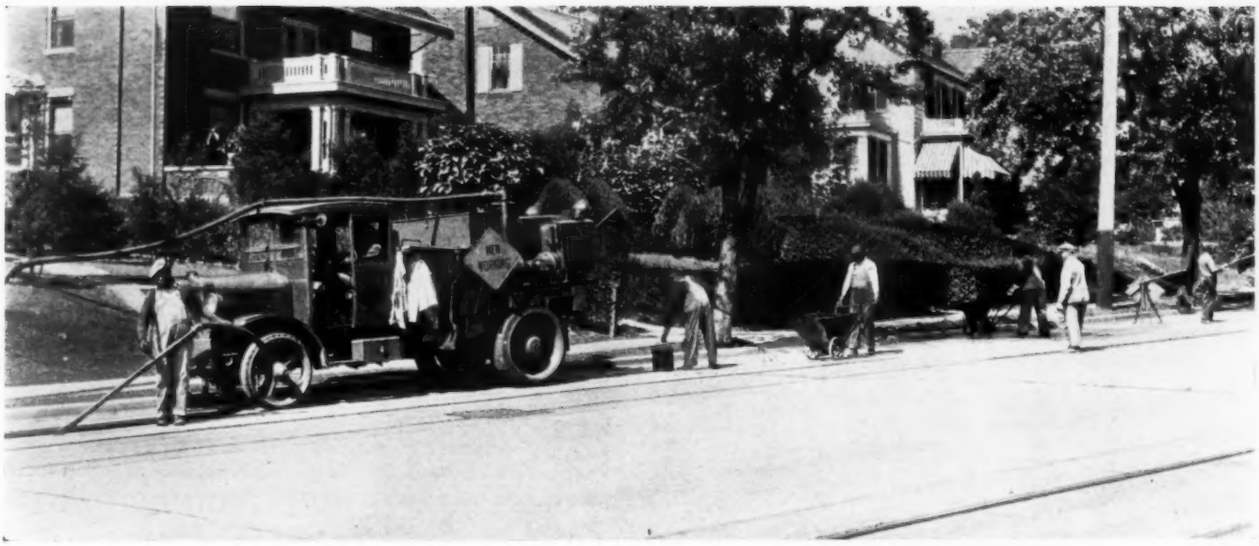


Fig. 6—Equipment Used by Street Department in Sealing Cracks in Concrete Pavement

mer operator is dressing the sides of the cut. The precast markers manufactured at the city structure yard are constructed of white limestone chips, white sand and white cement. The size of these markers is 6 in. by 2 in. by 12 in., the 12 in. length having been found to be the most practical for installation and replacement purposes.

Cleaning Loading Platform Bumper—8th St. Viaduct (*Fig.* 9).—Keeping loading platform bumpers clean is of utmost importance both to drivers and pedestrians. This cleaning is accomplished by a steam vapor combined with a cleanser. The steam is supplied by an oil-fired vertical boiler which is permanently mounted on this truck. This washing is accomplished at an average cost of 50 ct. per bumper.

Sand Blasting Loading Platform Bumper—Clifton Ave. (*Fig.* 10).—In spite of frequent cleanings it is necessary to annually paint loading platform bumpers. Preparatory to this painting, this crew is sand blasting this loading platform, light pedestal and bumper. The equipment used was mounted on the truck especially for this purpose. The average cost of this sand blasting is $1.90 per loading platform.

Fig. 7—Constructing Cast-in-Place Concrete Markers

Fig. 8—Installing Precast Concrete Markers

Spraying Loading Platform Bumper—8th St. Viaduct (*Fig.* 11).—Rapid drying white enamel is being sprayed on this loading platform bumper. The specially constructed trailer contains an air compressor, receiver, paint receptacle and all other equipment necessary for

Fig. 9—Cleaning Loading Platform Bumpers with Steam Vapor Combined with a Cleanser

this work, the cost of which averages $1.75 per loading platform.

Concrete Street Restoration Trailer—Hillside Ave. (*Fig.* 12).—This piece of equipment was constructed for use in the restoration of service cuts in concrete streets and streets having concrete bases. The fine and coarse aggregates are stored in compartments separated by a center vertical longitudinal partition. Water stored in the semi-cylindrical tank at the upper right is piped to the rear of the trailer. Cement and tools are stored in the waterproof compartments directly beneath the water tank, the cement being carried in the rear platform as necessary. The tail gate drops to form a horizontal platform on which the operator stands, his aggregate, cement and water, being readily accessible at this point. This equipment permits a 2-man operation, the wheelbarrow operator dumping the mixer and returning the mixer hopper to its original position.

Fig. 10—*Sand Blasting Preparatory to Painting Loading Platform, Bumper and Light Pedestal*

Anvil, Forge, Oil Tempering Bath at Repair Shop (*Fig.* 13).—The maintenance of the varied equipment employed in highway maintenance requires an extensive repair shop. This corner of the repair shop is devoted to the repair of the bits and drills used in air hammers. In the center background may be seen a special oil fired forge for this work. The operator has just removed the bit he is holding from this forge preparatory to inserting it in an automatic bit forging machine at the left.

Fig. 11—*Spraying Loading Platform Bumper with Rapid Drying White Enamel*

Fig. 13—*Corner of City Equipment Repair Shop*

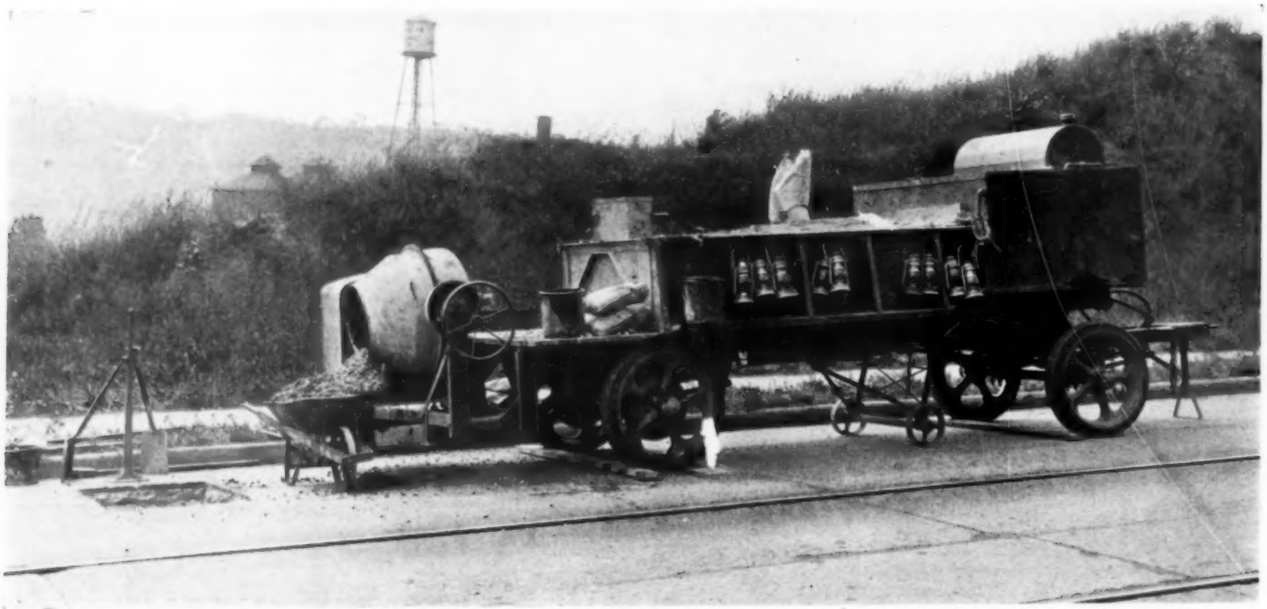


Fig. 12—*Equipment Used for Restoration of Service Cuts in Concrete Paved Streets and Street Having Concrete Bases*

8-MILE CONCRETE LANE MOVED WITH AIR JACK

THE New Jersey State Highway Department is now carrying out a most unusual road job—moving an 8-mile lane of concrete.

The project was inaugurated to provide a highway of the highest standard for safety on this important artery—the Brunswick Pike—a 39-ft. surface.

The 4-lane surface was inadequate for the heavy traffic which it served; another lane was needed. Before adding to the road it was considered advisable to separate traffic lanes, providing a parkway between traffic in opposite directions. So it was decided to move one lane of concrete to provide a 12-ft. parkway in the center of the road.

A method was devised and tried on a short section. It proved satisfactory. So application was made for WPA funds for the project. A grant was made which, in addition to moving the old slab, provides for a new lane of 10-ft. concrete pavement, draining, raising and

Slab on Left Moved 12 Ft. to New Position. Workmen Excavating for Drainage Ditch in Center of 12 Ft. Division Strip.

grassing the central parkway, and bordering the parkway with 18-in. white concrete curbs.

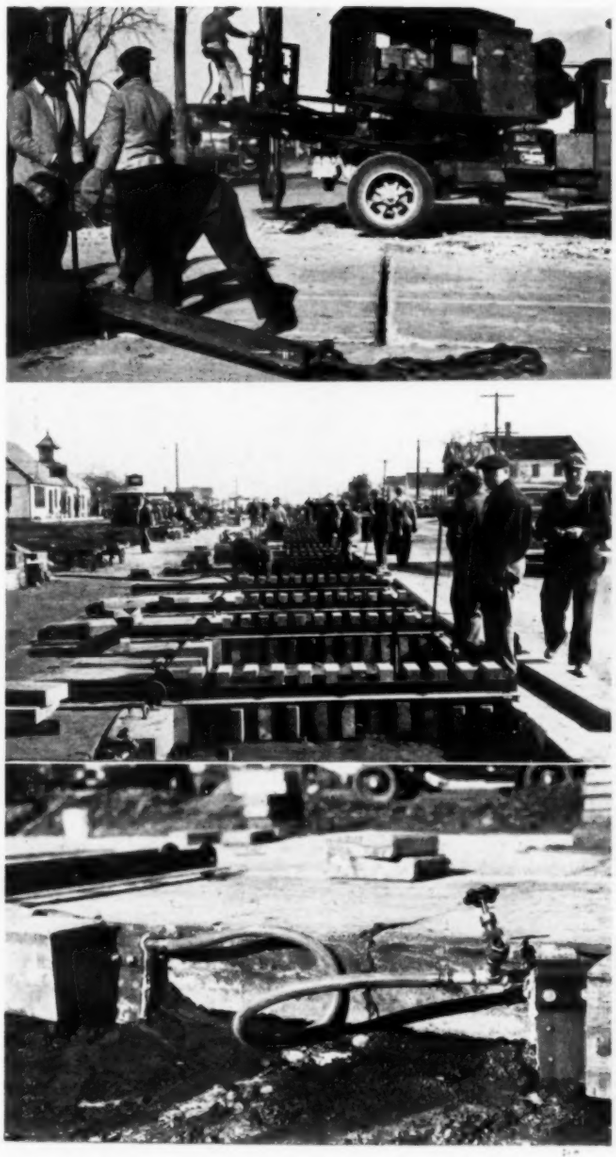
The road was first built 29 ft. wide in two 14½-ft. lanes with 9-in. uniform cross section. Later a 10½-ft. strip was added to provide for increased traffic, and plans made for a similar strip on the opposite side when increase in traffic required it. WPA provided the way to get this needed widening.

The method used in this work was developed by the engineers in charge. Naturally, it is important to obtain the same true surface of the road in its original location. Some means was necessary to "bed" the irregular under-surface of the slab, and to get a uniform bearing between the slab and the subgrade. The mud jack gave the solution.

The subgrade is excavated to a depth of approximately 10½ in. below the desired level of the road. When moved, the surface of the slab is from ½ to 1 in. below the desired level. This is easily taken care of and a true, even surface obtained by raising the slab with the mud jack.

The ½-in. premolded longitudinal joint is then plowed out to a depth of 7 in. with a sharp-nosed plow drawn by a power roller. The lane to be moved is cut into sections approximately 450 ft. long, a transverse joint being cut out for a width of several inches. Dowels are also cut off. This is done so that the pavement slabs can be moved as a unit for this length.

The slab is moved with a special 6-in. hose, which shifts the pavement 3½ in. with each inflation. Before



Top: Transverse Expansion Joint in Center of Picture Has Been Opened Up and Dowels Cut to Facilitate Slab Movement. Joint Remover Plow on Left. Pavement Breaker Removing Street Intersection Slab in Background—Angle Iron Strut Frames for Holding Wedging Blocks Used at Rate of About Four to Each 35 Ft. Slab. Special Air Line Connections Between Hose Units. Note Hose and Connections and Position of Hose Between Edge of Concrete and Blocking Timbers—Channel Dowel Transverse Joints in Place for New 10 Ft. Widening Slab. In This Instance a Gutter Section Also Is Being Built

Special Plow Used for Removing Longitudinal Joint Filler

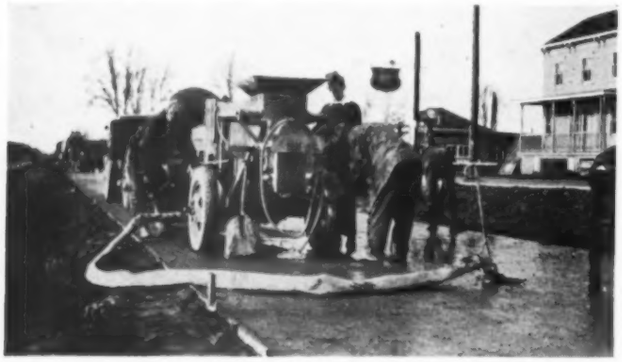
this hose can be inserted, a 2-in. fire hose is inflated in the plowed-out joint, which shifts the slab 2 in., enough to permit use of the larger hose.

The special hose is set up in 35-ft. lengths, with air release valves between each section. Air is provided by a battery of 5 compressors.

After each jacking operation, air is released, the heavy blocking timber which parallels the hose transmitting the pressures to the slab through the blocking, is pinched to a new position, 3½-in. blocks are inserted in struct frames designed to provide easy filling without permitting buckling. These are spaced on 7-ft. centers. Then the hose is inflated again. This cycle is repeated until the slabs have been moved the desired distance.

Before mud-jacking to level the pavement, stiff mud is tamped along the edges of the slab. This process is then carried out in accord with accepted practice.

Standard methods are used for building the 10-ft. concrete widening strip. In this, channel dowel transverse joints are used, spaced at the same intervals as the joints in the old pavement.



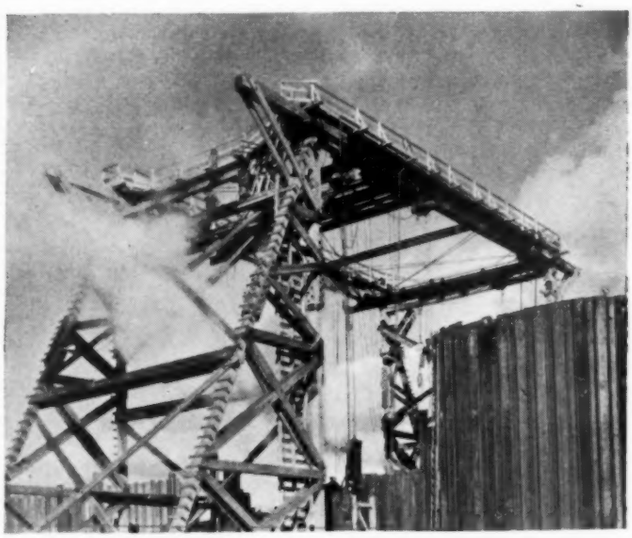
Bedding Slabs at Proper Elevation After Moving to New Position with Mud-Jack. A 1-6 Cement-Top Soil Mixture Is Used.

Drainage is provided in the center parkway by filling a hand-excavated trench with stone. Curbs with white cement face are built on each side of the parkway and the parkway is landscaped.

The initial project, eight miles long, is being built as a WPA project. Excellent results have been obtained, the rigid concrete slabs showing no damage from the moving. And the surface has been leveled to equal the original trueness. As a result of the success of the operation it is planned to extend this work an additional 32 miles.

Novel "Gang Pile Driver"

The illustration shows one of the ingenious pile driver rigs set up by the Mason, Walsh, Atkinson, Keir Company, contractors, to sink the sheet piling for cofferdams at Grand Coulee.



Gang Pile Driver Used for Cofferdams at Grand Coulee

Hammers, suspended on steel cable, are raised and dropped by electric hoists. Three such rigs are used, each comprising a battery of six P & H hoists of 5-ton capacity and operating six hammers. The hoists are mounted in series on an I-beam trolley for quick positioning and operated by rope control.

Cost of Patrol Street Sweeping

The following figures on the cost of hand-broom sweeping of improved streets in two Canadian cities are taken from a paper presented at the 1935 meeting of the Canadian Institute of Sewage and Sanitation by H. D. Bradley, Commissioner of Streets, Toronto, Ont., and from a discussion of Mr. Bradley's paper by Stanley Shupe, City Engineer, Kitchener, Ont.

	Toronto, Ont., population 629,000	Kitchener, Ont., population 30,000
Total cost (foremen, labor, cartage, supplies)	$246,155	$11,907
Area improved street mileage (sq. yd.)	9,222,435	601,920
Maintenance cost per season (1000 sq. yd.)	$26.69	19.78
Amount of sweepings collected (cu. yd.)	127,659	3,500
Cost sweeping, collecting and removing (per cu. yd.)	$1.93	$3.40
Removed per 1000 sq. yd. per season (cu. yd.)	13.8	5.82
Number of patrolmen	187	20
Average area maintained per patrolmen (sq. yd.)	49,000	30,096
Average number of times swept per season	90	80
Cost of sweeping per 1000 sq. yd. (sweeping, collecting and removing)	$0.30	$0.25

TRAFFIC STRIPING IN CALIFORNIA
A Short Account of Machines, Methods and Materials

By W. A. SMITH

Assistant Maintenance Engineer, California Division of Highways

THERE is, perhaps, no other single item of highway safety work which receives the favorable comment accorded the traffic stripe. Those whose business requires that they travel the highways at all hours and seasons would frequently find themselves in difficulties except for this white guide line.

From a small beginning in the fall of 1926—when one single striping machine was sent out to cover the state-wide program—this phase of maintenance work has expanded until at the present time each of the eleven highway districts is equipped with a modern outfit and the Los Angeles and San Francisco crews are operating practically continuously. Some 5,000 miles of the highways are now striped with a total of 7,500 stripe miles.

The placing of the stripe would appear to be a simple mechanical matter, but on the contrary a considerable amount of study and experiment have been required to develop satisfactory material, equipment and methods to secure a true, uniform, enduring, and economical stripe.

Qualities Required in Lacquer.—The cost of the lacquer is a very considerable item, and since the service to which this material is subjected is severe, it follows that a nice balance must be maintained in the formula to insure a reasonable service life at a minimum cost. The preparation of specifications for the lacquer now used was developed by the materials and research laboratory of the Division of Highways following considerable experiment and testing.

Spotting a Center Line

The work requires that the lacquer dry without tracking within 15 to 30 minutes. It must give a satisfactory coverage, resist discoloration when placed on an asphaltic surface, flow readily through the spray machine, adhere strongly to the surfaces on which applied, and endure extremes of weather as well as the abrasion of traffic.

The inspection of the raw materials used, as well as all processes of manufacture, is under the supervision of a representative of the Materials and Research Engineer. During the past two years an unusually uniform and satisfactory material has been thus insured.

Machines.—The first machine assigned to the work consisted of a paint tank and small compressor mounted on a small carriage. It was hand propelled. The paint tank held about eight gallons and the delays incident to mixing the lacquer and filling the machine were so great that only from three to five miles of stripe could be placed in a day.

As shown by the accompanying photographs, the new equipment as developed by the Equipment Department of the Division of Highways is a great improvement over the old. The paint tank and compressor have been removed from the spray machine proper and placed in the body of the truck tender. Ample air and paint capacity have been provided. Large wheels have been placed on the spray unit; the wheelbase lengthened; and an easily controlled pointer or guide provided to insure a true, uniform line.

Provision is made to permit cleaning the pavement surface with compressed air in advance of striping, and in some cases a small pump is provided to salvage the excess lacquer blown against the slide plates or discs which govern the width of line.

Methods.—The fresh line is protected while drying by small markers consisting of a coiled wire carrying a red flag. These markers are placed from the rear of the tender truck as the work progresses and are picked up from a light car when the line is dried sufficiently.

On sections of road not previously striped and on curves where the line has been obliterated, care is taken to spot the center line in advance of striping to insure a true, even appearing line.

A considerable mileage has been let out to contract from time to time and several contractors have developed outfits which are equal to the state units. In the main, however, the striping work is handled by state forces due to the intermittent character and necessity of getting it under way promptly.

Whether handled by contract or by state forces, the same standards of work are adhered to. Lacquer is applied at the rate of from 8 to 12 gal. per mile of 4-in. stripe on restriping, and from 12 to 18 gal. per mile on new work, depending on the type and condition of surface.

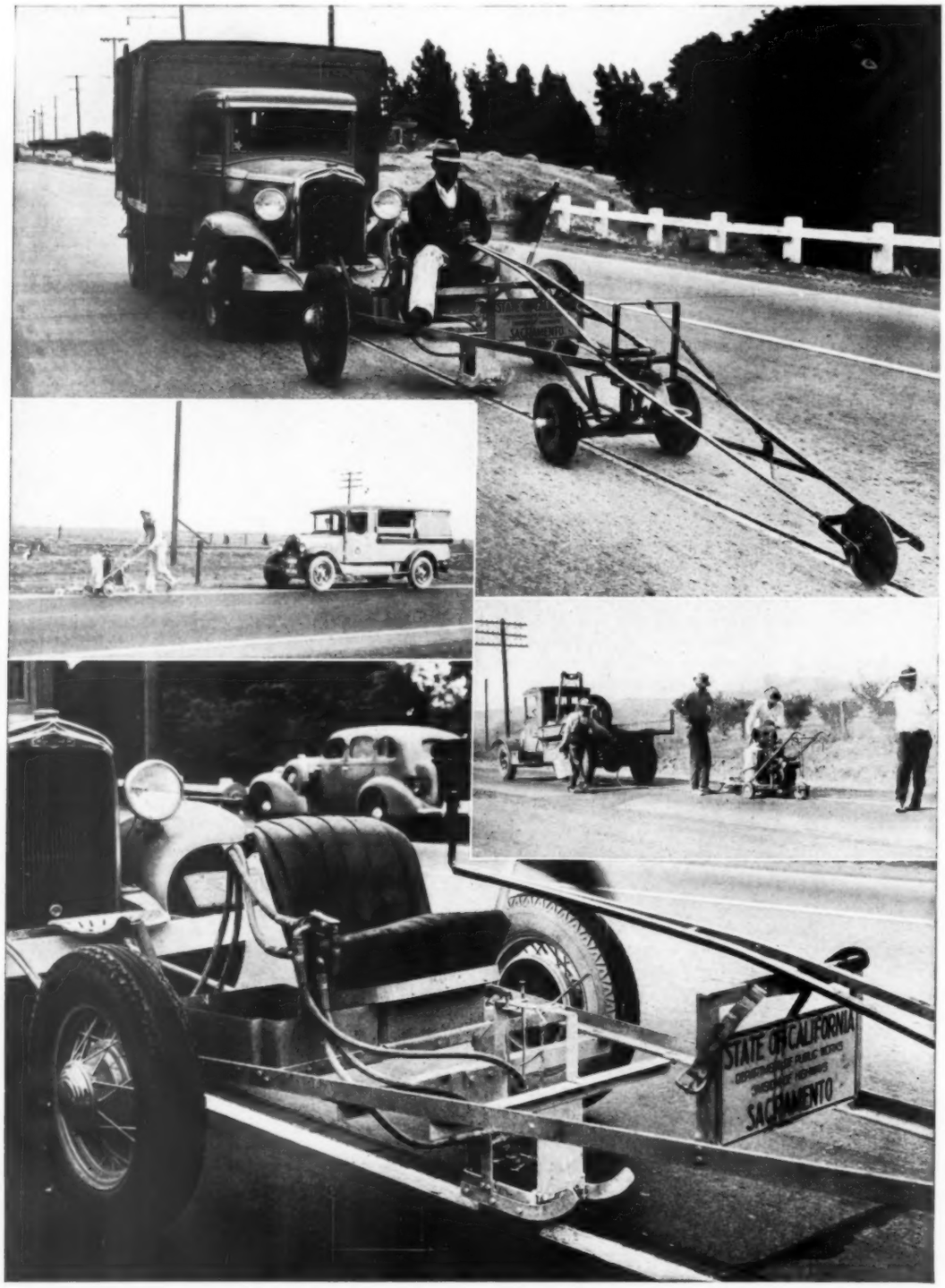
Cost.—An experienced crew will place from 10 to 25 miles of stripe per day with an average of about 18 miles per day. The cost ranges from $25 to $30 per mile, depending on conditions as to spotting, traffic, road alignment, etc.

In general, the stripes are renewed once a year, although on certain heavily traveled roads in the Los Angeles and San Francisco areas it is necessary to restripe about every six to nine months.

The foregoing is from the July issue of California Highways and Public Works.

The Srtping Crew and Its Work.—The following additional information has been supplied by the Division. When the marking out of the center line of the stripe is required, the work is done by three men, two to place and hold the rope, and the third to spot the points which are placed about 16 to 18 in. apart. A Ford Express, or similer equipment, is assigned to this crew.

The striping crew consists of the operator of the striping machine, a truck driver, and three men in the rear of the truck, two to mix the lacquer and fill the container, and the third to place the flags. When the striping work is running continuously, the flags are picked up by two men with a light car which follows the striper crew. This crew also place the signs re-



Two Views of the New Traffic Striping Machine of the California Division of Highways, with Inserts Show-the Old Hand-Propelled Machine. The New Machine Averages 18 *Miles of Stripe Per Day—the Old,* 4 *miles. Illustrations by Courtesy of California Highways and Public Works*

quired, etc. The working day starts when the men leave the yard, and ends eight hours later plus the lunch hour. The men return to the yard on their own time.

State of California Specifications for White Traffic Line Marking Lacquer

(a) The lacquer described herein is intended to best meet service requirements. All materials used shall conform to the specifications, and where specifications are not entirely clear or appear to allow varied interpretations such cases shall be brought to the attention of the Testing Laboratory of the Division of Highways.

(b) All materials used in the manufacture of the lacquer shall be subject to test by the Division of Highways. The contractor for the lacquer shall notify the testing engineer of his intention to manufacture the lacquer at least five (5) days prior to the beginning of the mixing of any lacquer; and the engineer shall be given free access to sample, test and seal containers of any material to be used in the manufacture of said lacquer. Samples adequate for test shall be furnished free of charge by the contractor, and all such samples shall be taken and identified by the engineer. Tests shall be made in accordance with the methods specified by the American Society for Testing Materials. Where no such methods are specified for the material to be tested, the testing engineer shall prescribe and make such tests as he deems necessary. No lacquer shall be mixed until all ingredients entering into the lacquer formula have been tested and approved by the engineer.

After mixing, the engineer shall seal the containers of mixed lacquer and such seals shall not be broken until the time of application. After being sealed by the engineer at the mixing plant no further test, except the weight test, will be required, unless there is evidence that additions other than herein specified have been made subsequent to sealing at the mixing plant.

All manufactured lacquer shall be mixed at the factory ready for application through the state lacquer spray machines without necessity of the use of a thinner.

The composition of the lacquer shall be as follows:

Pigment

Shall be a precipitated product having the following composition:

	Per Cent
Titanium Oxide	24-25
Barium Sulphate	76-75

Solvent

	Per Cent by Volume
Raw Tung Oil (China Wood Oil)	15
Normal Butyl Alcohol	17
Acetone	34
Denatured Alcohol Formula No. 1	34

Mix the butyl alcohol, acetone, and denatured alcohol and then add the wood oil.

Raw Tung Oil

Raw tung oil shall conform to the following requirements:

	Max.	Min.
Specific Gravity at 15.5° C.	0.943	0.939
Acid Number	6	
Saponification Number	195	190
Unsaponifiable Matter, per cent	0 75	.....
Refractive Index at 25° C.	1.520	1.515
Iodine Number (Hubl. 18 hours)	.....	165
Heating Test (Browne's Method), min.	12	.....
Iodine Jelly Test, minutes	4	.....

Gum Vehicle

	Per Cent by Weight
Gum (East Indian D.B.B.)	35-37
Solvent (as above)	65-63

Lacquer

	Per Cent by Weight
Pigment (as above)	42-45
Gum Vehicle (as above)	58-55

Add sufficient Prussian Blue in oil to overcome the yellowish tint.

Lacquer shall be mill ground.

The volatile material shall have a minimum solvent action on asphalt and be of such character that the gums and non-volatile components will entirely dissolve therein and will not precipitate from the solution on standing. The non-volatile matter shall not darken or become yellow when a thin section is exposed to the sunlight.

General Requirements

The properties desired in white line marking lacquer and which will be required are as follows:

1. It shall remain white under service conditions.
2. It shall dry under ordinary conditions suitable for opening to traffic in from fifteen (15) to thirty (30) minutes after application. Method of test for rate of drying will be determined by the laboratory.
3. It shall show non-bleeding of oil or asphalt into the stripe.
4. It shall have good covering properties.
5. It shall have good elasticity.
6. It shall have good durability under extreme weather conditions.
7. It shall satisfactorily resist the abrasive action of traffic as determined by the method in use at the Testing Laboratory.
8. It shall have good visibility.
9. It shall be of such consistency that the material may be used in the state paint spray machines without the use of thinner.
10. The lacquer shall not cake or become unduly separated from the vehicle in storage.

The lacquer will be subjected to the following tests:

Drying Time

When the lacquer is applied to an asphalt pavement at the rate of fifteen (15) gallons per mile it should dry without tracking in from fifteen (15) to thirty (30) minutes. Panels of different materials are dipped in the thoroughly mixed lacquer, the surplus paint allowed to drain and then placed in a vertical position and maintained at a temperature from 70° to 90° F. and the drying time as noted. This drying time must not exceed thirty (30) minutes, as determined by the testing engineer.

Covering

Panels of bright tin marked by painting two diagonal black lines one-half inch in width from opposite corners with one coat of drop black in oil thinned with turpentine and dried so as to obtain a suitable body to give proper brushing, flowing, and covering properties, and wood panels of white pine painted in the same manner as are the tin panels are prepared and allowed to dry for forty-eight (48) hours. The material under test is then painted by hand upon both the tin and wood panels and after seventy-two (72) hours the diagonal black lines shall not be visible through the lacquer coating.

Bend Test

Clean, plain, tin panels, 3 mm.-4 mm. thick and 10 cm. by 15 cm. in size, are painted by hand and allowed to dry for seventy-two (72) hours, and are then bent rapidly over a rod one-half (½) inch in diameter. There should be no more than slight cracking of the paint film under this test.

Water Test

Plain panels prepared as in the paint test are placed in cold water at room temperature for forty-eight (48) hours, other panels are placed in hot water at 200° F. for one hour, and still others are placed in boiling water for fifteen (15) minutes. The condition of each class of panel is noted after having been removed from the water at the end of two hours. There should be no marked disintegration.

Bleeding Test

When the lacquer is painted upon specially prepared asphalt discs containing an excess of asphalt, no discoloration of the paint film when dry should take place when the material has been applied at the rate of fifteen (15) gallons per mile.

Thinner furnished for use in cleaning out the paint spray must be of the same nature as the vehicles used in manufacturing the lacquer.

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Increased Employment High Spot in Road Building of Past Year

Increased employment was the dominant note in the Federal highway program for the year ending June 30, 1935. Directly and indirectly Federal highway activities accounted for more than 5,000,000 man-months of employment, according to the annual report of Thomas H. MacDonald, Chief of the Bureau of Public Roads. The average full-time direct employment on road work involving Federal funds was 182,605 men or more than 2,000,000 man-months. Indirect employment has averaged approximately 1.4 times the direct employment, or more than 3,000,000 man-months.

Bridge Painting Costs on Illinois State Highways

VALUABLE records of the cost of painting steel bridges by day labor have been kept during the past three years by the Illinois Division of Highways. Details of these costs are given herewith, and show a marked improvement in efficiency in 1934 over 1933. Data for 1935 are not yet available.

All of the bridges here listed are small, and transportation costs per ton painted are accordingly high as compared with costs on larger structures.

The kind and quality of paint were in accordance with the standard specifications of the State of Illinois. In 1933 either blue lead or white lead was used—in 1934, white lead only. Paint was applied in 2 coats totaling about ¾ gal. per ton of steel on all the bridges except that four girder spans as noted in Table II, were painted one coat only.

Most of these jobs were done by a gang of 6 painters under one foreman. The painters were paid 6 ct. per hour, and the foreman $175.00 per month. At the present time, painters receiver 75 ct. per hour. The working day was 9 hours in 1933 and 1934; in 1935 it is 8 hours. The foremen did very little actual painting bevond touching up the finish.

The work done in 1933 (shown in Table I herewith) was the first by the present organization and under the present system. Labor efficiency was very low—in fact, only about one-half the present efficiency. Marked improvement was made in 1934, and it is considered that a fairly good standard of efficiency was attained in that year, although the same crews have made better records in 1935.

TABLE I—COST OF PAINTING SEVEN BRIDGES—2 COATS—BY DAY LABOR IN 1933

Location	Sangamon Co.		Schuyler Co.		Knox Co.		Jackson Co.		Jackson-Union Cos.		Gallatin Co.		Hardin Co.	
Type of bridge	Truss		I-Beam		Truss		Truss		Truss		Truss		2-Pony Truss	
Tonnage	362.84		111.7		51.44		64.34		51.3		51.3		74.45	
Method used	25% Brush 75% Gun		Brush		Brush		Brush		Brush		Brush		Brush	
	Total cost	Cost per ton	Total cost	Cost per ton	Total cost	Cost per ton	Total cost	Cost per ton	Total cost	Cost per ton	Total cost	Cost per ton	Total cost	Cost per ton
Cleaning	$ 22.33	$0.062	$ 45.29	$0.405	$ 20.23	$0.392	$ 55.01	$ 0.855	$ 0.00	$0.000	$ 33.69	$0.657	$ 21.57	$0.290
Spotting	27.36	0.075	9.19	0.082	1.87	0.036	12.66	0.197	7.06	0.138	11.53	0.225	0.47	0.006
Prime coat	187.83	0.518	53.53	0.480	103.02	1.996	214.33	3.331	55.25	1.077	107.42	2.094	190.28	2.556
Second coat	345.21	0.951	61.02	0.546	101.99	1.979	144.78	2.250	55.93	1.091	139.63	2.722	152.24	2.045
Rigging	10.79	0.030	10.63	0.095	1.60	0.031	24.51	0.381	8.96	0.174	19.47	0.379	12.56	0.169
Transportation	54.45	0.150	43.18	0.387	38.99	0.757	141.58	2.200	12.26	0.239	49.38	0.963	97.73	1.313
Tools	0.00	0.000	0.00	0.000	1.35	0.026	44.54	0.692	53.21	1.037	53.22	1.037	59.22	0.795
Material	65.01	0.179	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	9.00	0.175	4.50	0.060
Inter-dept. chgs.	0.00	0.000	0.00	0.000	0.00	0.000	6.75	0.105	0.00	0.000	0.00	0.000	0.00	0.000
Total excl. paint	$ 712.98	$1.965	$222.84	$1.195	$269.05	$5.220	$644.16	$10.011	$192.67	$3.756	$423.34	$8.252	$538.57	$7.234
Paint	635.05	1.750	134.35	1.203	56.50	1.097	64.10	0.996	34.5	0.672	59.34	1.157	85.56	1.149
Total incl. paint	$1,348.03	$3.715	$357.19	$3.198	$325.55	$6.317	$708.26	$11.007	$227.17	$4.428	$482.68	$9.409	$624.13	$8.383

Total cost, exclusive of paint..... $3,003.61
Total tons of steel painted..... 767.37
Average cost per ton exclusive of paint..... 3.91
Average cost per ton for paint..... 1.39
Average cost per ton including paint..... 5.30

TABLE II—COST OF LABOR AND EXPENSE PAINTING THIRTY BRIDGES IN 1934

(Cost of paint and overhead not included in this table)

Location—County	Type of bridge	Tons of steel painted	Total cost	Cost per ton
Whiteside	Girder or I-beam	80.635	$ 252.77	$3.13
Bureau	Truss	86.150	574.03	6.66
Bureau	Truss	61.700	456.31	7.39
Bureau	Truss	71.875	503.00	7.00
Knox	Girder or I-beam	114.095	499.69	4.38
Piatt*	Girder or I-beam	68.975	91.12	1.32*
Cumberland	Girder or I-beam	42.650	153.70	3.60
De Witt	Truss	175.300	754.28	4.30
Logan	Truss	86.440	728.76	8.43
Pike	Truss	46.785	277.76	5.93
Pike	Truss	259.165	680.29†	....
Pike	Truss	64.492	450.33	6.92
Edwards*	Girder or I-beam	53.185	84.42	1.50*
Washington	Truss	58.840	359.99	6.12
Bond	Girder or I-beam	462.355	925.60	2.00
St. Clair	Girder or I-beam	48.875	87.64	1.79
Madison*	Girder or I-beam	32.706	45.63	1.39*
Madison	Girder or I-beam	155.555	352.71	2.27
St. Clair	Truss	126.135	208.38	1.65
St. Clair	Girder or I-beam	34.040	107.27	3.15
Bond	Girder or I-beam	41.555	117.28	2.82
Union	Girder or I-beam	50.570	308.51	6.10
Jackson	Girder or I-beam	47.800	76.52	1.60
Franklin*	Girder or I-beam	64.870	84.44	1.30*
Johnson	Girder or I-beam	54.731	88.19	1.61
Franklin	Girder or I-beam	35.150	67.66	1.92
Alexander	Truss	275.090	1,367.34	4.97
Randolph	Girder or I-beam	53.750	139.71	2.60
Franklin	Girder or I-beam	92.350	192.10	2.08
Jefferson	Girder or I-beam	48.275	98.19	2.03
		2,894.094	Average	$3.66
	Not finished	127.000		
	Completed	2,881.394		

*Painted one coat only.
†Painting incomplete. Balance to be finished—127 tons.

TABLE III—AVERAGE COST OF LABOR AND EXPENSE ON BRIDGE PAINTING IN AUGUST AND SEPTEMBER, 1934

(Cost of paint not included in this table)

Type painting	Costs per ton of steel painted: Transportation	Scaffolding	Cleaning	Spot coat	Prime coat	2nd coat	Exp.	Total
Truss— 2 coats white	$0.12	$0.325	$0.821	$0.082	$1.978	$1.325	$0.30	$4.95
I-Beam Overhead— 1 coat blue	0.053	0.00	0.558	0.23	0.81	0.000	0.30	1.95
I-Beam Overhead— 2 coats blue	0.404	0.000	0.399	0.236	1.00	0.618	0.30	2.96
I-Beam— 2 coats white	0.048	0.108	0.331	0.052	0.564	0.603	0.30	1.74

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DRIFT CONTROL—During the winter of 1933-1934, 9,213 miles of snow fence and 30 miles of trees and hedge were used as barriers on main highways to prevent the formation of drifts on the roads. This is an increase of 1,007 miles in the last 5 years.

MEANS FOR REDUCING MOTOR VEHICLE ACCIDENTS

Extracts from Papers Presented before the Street and Highway Traffic Section at Annual Safety Congress, October 14-18

Planning Traffic for Easier Enforcement

By HOWARD F. ILGNER

Chairman and Engineer, Traffic Committee, Milwaukee Safety Commission

DISOBEDIENCE of traffic laws and regulations surpasses the disobedience of any other set of laws on the statute books today. In many instances it is a reckless type, while in others it is disobedience caused by conditions which make obedience difficult and illogical.

What Traffic Engineering Should Provide.—Enforcement alone has not produced a satisfactory answer. The real problem is the adaptation of the motor vehicle to society. Traffic engineering should provide for the safety of the motorist and pedestrian with a minimum of annoyance or interference to either. If this is done enforcement is at once made easier because there is no reason for disobedience except utter recklessness and disregard for others.

With 65 per cent of all the motor vehicle fatalities in cities being pedestrians, it is almost a foregone conclusion that traffic planning must give very important consideration to the pedestrian. Elevated sidewalks and pedestrian tunnels are not the solution. Any immediate progress to be made on a large scale must be made on the street surface.

Proper Timing of Traffic Signals Important.—The answer is that of good traffic planning making enforcement easier. The proper timing of traffic signals is, without doubt, an important item. Long cycles which cause unnecessary delay to both vehicular and pedestrian traffic should be avoided. Pedestrians, who should also obey traffic signals as well as motor vehicles, often are led to disobey such signals because of long waits which seem to them unreasonable. That accurate timing of traffic signals to meet the needs of the intersection is an important feature has been shown by accident statistics at a number of intersections where no other change was made except reducing the time cycle. Very often cycles can be reduced to the time actually required for pedestrians to cross the street.

Another item is the proper interconnection of signals for progressive operation. Signals installed at reasonable intervals, properly timed and interconnected, can give almost perfect speed control 24 hours of the day. Motorists who habitually use such streets soon get tired of rushing and stopping, rushing and stopping, and find that by getting into the orderly rhythm of a well-timed progressive system they can drive more easily and safely. The speed problem has then been solved. Arrests for speeding on such streets are few, and driving becomes a pleasure instead of a constant strain.

Experiences at Milwaukee with Signals.—Trouble has also been experienced in the past by motorists starting on the amber-green combination on the cross street while their own signal is still red, in other words, "jumping the lights." This has been especially troublesome to pedestrians who are trying to cross the street at the end of the cycle. The amber and green combination usually shows for 3 or 4 seconds, giving the driver who jumps a light a chance to get out to the center of the intersection before the lights flash "Go" on his own street. Experiments were made in Milwaukee at a number of busy street intersections using a short amber of approximately 1 second with the red, and the results so far have been very satisfactory. This has created a tendency for drivers to watch their own signals instead of the cross street signals and has greatly decreased jumping of lights. At first even those who started out on the cross street amber seemed to become momentarily confused by the second amber which appeared on the red, and stepped on their brakes. As soon as they became accustomed to the amber on the red they seem to be satisfied to watch and obey their own signal. The amber on the red, being one of 1 second duration, is so short that it just covers the time it takes for the motorist to make up his mind and get ready to start.

The Pedestrian the Forgotten Man.—In traffic control work the pedestrian has heretofore been the forgotten man. Laws in general provide that a pedestrian stepping off the curb on the green light has the right-of-way over vehicles until he reaches the opposite curb, even though the signals should change to red while he is crossing. This regulation has not been successful. A pedestrian stepping off the curb at the end of the green is usually trapped in the roadway between lines of moving vehicles. Great care has been taken to tell the motor vehicle driver that the green is about to change to red and that he should stop, but the pedestrian generally has not had a signal which gives him an opportunity to do anything. A signal which may be ample for a vehicle moving 30 feet per second is not ample for a pedestrian who walks only 5 ft. per second; in other words, an amber light which gives a correct indication for motorists does not take care of pedestrians.

In order to overcome this, special "Walk" indications have been added to the vehicle signals. This "Walk" indication is usually used in one of two ways:

1. A complete stopping of all vehicular traffic and the display of the "Walk" signals in all directions. While this is the 100 per cent safe way, nevertheless if used at all intersections it would considerably hamper vehicle traffic movement.
2. The "Walk" signal may be used in conjunction with the green vehicle indication, coming on with the green and going off before the end of the green, in time so that the last pedestrian stepping off the curb on the "Walk" signal can reach the opposite curb in safety. This system gives the pedestrian a true clearance indication but, of course, still subjects him to turning traffic.

The "Walk" Signal.—However, for general use the latter system is to be preferred, inasmuch as it is a fair balance between the rights of the pedestrian and the

rights of the motor vehicle. Vehicles making turns have generally been educated to the fact that the pedestrian has the right-of-way on the green light.

When the first "Walk" signals were experimented with in Milwaukee, they were hooded and baffled in such a way that vehicular traffic could not see them to any great extent. It was thought that this additional signal might be confusing to traffic. However, in our latest experiment we have removed all the baffles and the long hoods, and the "Walk" indications are in plain view of the motor vehicle traffic. This has a surprising effect on motorists making turns. It seems immediately to bring to their minds the fact that pedestrians have the right-of-way and they then generally make turns with more caution.

Traffic Islands at Milwaukee.—At complicated intersections and on side roadways channelization of motor vehicle traffic by means of traffic islands is a most important method of improving conditions. Such channelization separates the various moves of vehicular traffic, providing greater safety for the motor vehicle and the pedestrian. A pedestrian with only short distances to travel between curbs, knowing where motor vehicles are going and having to watch traffic from only one direction, is in a much safer position than one who has to negotiate long crossings amid non-channelized and confused vehicle traffic.

These traffic islands in Milwaukee are of low type construction, offering no great hazard to motor vehicles and yet commanding attention so that no vehicle would deliberately ride over them. The edges or corners of these islands are plainly marked by amber traffic markers which are illuminated at night from the street lighting circuits. These amber marker lights are right down on the islands. In fact, they form part of them. They are not up off the ground where they can be confused with other lights or where they can be easily obliterated by the glare of on-coming headlights.

In case a mistake is made by a driver, which has happened, he may bump the traffic marker or go over the corner of the island, but very rarely is he injured. Also up to the present time no fatalities have occurred in Milwaukee to pedestrians using these islands, which this year is a better record than for our sidewalks.

New Pavement Marking Scheme. — Considerable trouble has been experienced with motorists driving up to crosswalk lines or slightly over them. We have now adopted a new pavement marking scheme at intersections, in which an additional line or stop line is painted about 4 ft. in advance of the crosswalk line. The space between the crosswalk line and the stop line is generally called the avoidance zone and has worked out very satisfactorily.

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Regulating Speeds on City Streets and State Highways in Municipalities

By RALPH W. EATON

City Traffic Engineer, Providence, R. I.

TWO important factors in the control of speed are officer supervision of motor vehicle operation and the accumulation of the necessary data so that such supervision may be properly directed. If motorists can be given the impression that their operations are under supervision, they will drive more carefully and safely.

The Providence System.—This system has been in effect in Providence since 1932. In that year the Traffic Bureau began making monthly measurements of speeds of vehicles at various points of the city, employing civilian observers to do the work. The question soon arose as to what the observer should do when he observed a flagrant violation of the traffic rules. Since he had no official power, it was decided that he should merely report the registration number of the vehicle to Police Headquarters. The operator of the vehicle would then be summoned for an interview, in the course of which the seriousness of his offense and the danger which he created were thoroughly explained.

These interviews, in nearly all cases, have been well received and the drivers leave with a better understanding of the situation and with an intention to drive more carefully. Although the system has proved satisfactory in Providence, attention is called to the fact that its success is greatly dependent upon the tact and ability of the police officer who conducts the interview.

Speed Control Where State Highways Enter Cities.—Mr. Eaton also touched upon the problem of controlling speed when state highways enter and traverse municipalities. An acute problem is created, he said, when the state road—wide, well engineered, constructed for modern, high speed driving—dumps its traffic into streets which are often of insufficient width, poor geographical lay out, solidly built up, and having intersection and pedestrian problems. The problem would be obviated if motorists reduce their speed and increased their alertness as conditions demand, but unfortunately, he stated, drivers usually fail to respond. Among the reasons for this are that they fail to appreciate the degree of reduction required, and that they are impatient with the delay encountered in going through a town. As a remedy for this, he suggested the posting of signs demanding progressive reduction in speed as the highway approaches the town, so that, for example, the motorist on a state highway zoned for 40 miles an hour will, on his approach to the city, pass signs indicating successive 35, 30 and 25 miles an hour. Additional signs may also be installed, indicating that traffic is entering a more heavily populated section.

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Training the Changing Family of Traffic Officials

By ROGER L. MORRISON

Department of Highway Engineering and Highway Transport, University of Michigan

UNLESS something definite is done for the education of the four branches of traffic officials, safety campaigns in themselves can do little to reduce the nation's enormous traffic casualty toll.

At present, Professor Morrison said, the main effort toward traffic accident reduction is a barrage of speeches, articles, and posters, telling how serious the situation is and pleading with the drivers and pedestrians to be more careful. While this is desirable, and even somewhat effective, it is unfortunately true that certain persons who cause a large portion of the accidents are the least likely to be influenced by such activities. State, county and city governments are clearly shirking an important part of their responsibility as long as they fail to provide adequate training for their traffic officials, Professor Morrison asserted.

Traffic Officials Classified.—He classified traffic officials in four principal branches—the legislative branch, which makes the traffic laws; the punishing branch,

which applies the penalty for failure to observe the traffic laws; the engineering branch, which evolves the pattern for the laws; and the enforcement branch, which seeks to prevent violation of the laws.

It is obvious that all the members of the legislative branch could not be given the same kind of training, nor do they need the same training, for in the final analysis they do not actually make the laws, but merely enact them according to the pattern outlined by the traffic engineers.

The education of the punishing branch can best be accomplished by interesting judges and prosecuting attorneys in safety movements. They will then come to regard traffic violations as more serious infractions of the law and will not dismiss too many offenders with light sentences. In the past it has been found that light sentences for traffic offenders have often seriously handicapped the work of the police.

Education of Engineering Branch.—The education of the engineering branch is now being undertaken by several colleges and universities in this country, so that it is reasonably safe to say this branch is being well taken care of. During the past several years it has come to be recognized generally that mere "common sense" will not always solve a difficult traffic situation. It is now definitely understood that scientific training must be given highway engineers.

The training of the enforcement branch, such as police officials and traffic officers, requires first of all a recognition of the fact that such training is needed. The knowledge gained by traffic engineers must be passed on to the enforcement branch, which should hold a training school periodically. The ideal training for every traffic officer, Professor Morrison said, would be to have a month of instruction in traffic problems at some recognized educational institution, preferably a university.

Until such a plan can be put into operation, traffic officers should be encouraged to attend highway and safety conferences.

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When and How Automobiles Skid

By R. A. MOYER

Associate Professor of Highway Engineering, Iowa State College, Ames, Iowa

SOME of the interesting findings in a four-year study of the automobile skid, were discussed by Prof. Moyer. Prof. Moyer directed the skidding tests at various speeds, under all sorts of weather conditions, on all sorts of roads and with all kinds of brakes and tires.

All surfaces except gravel and cinders, he said, increased in slipperiness with an increase in speeds. The great majority of skidding accidents occur during the four months when wet, icy and snow-covered roads are common.

Mud, Snow and Ice-Covered Surfaces Most Hazardous.—The results of the test on mud, snow and ice-covered surfaces indicated that they constituted the most hazardous road conditions which the motorist is likely to encounter.

Chains do not prevent skidding when the driver speeds, he stated. Under no circumstances should a driver with chains go more than 30 miles an hour on icy rural highways or 15 miles an hour on city streets. The best protection against skids is to sprinkle sand or cinders treated with calcium chloride over as much of the road as practical. The calcium chloride will hasten the process of embedding the gritty material into the ice.

The following points were also brought out by Prof. Moyer:

Snow is not nearly as dangerous as ice from the skid standpoint. Mud-covered pavements can be as dangerous as ice-covered pavement.

At speeds greater than 15 miles per hour tires with treads worn smooth are more slippery on wet surfaces than tires with a non-skid tread design. Resistance to skidding is lessened if there is an overload on truck tires. Tires should be kept at a pressure slightly above the recommended minimum. Under-inflation induces skids; also over-inflation.

Brakes Cause More Skidding Accidents.—Faulty brakes and the improper use of brakes are the cause of more skidding accidents than any other driving operation. Unequalized brakes are extremely dangerous. Of 2,134 cars tested, 31 per cent had brakes with 40 per cent more braking effort on one side than on the other. Practically one-half of the 2,134 cars tested had faulty and inadequate brakes.

Cause of Skidding on Curves.—In driving around curves it should be kept in mind that there is only one speed at which the centrifugal is exactly balanced by the gravity force. A car traveling slower than this speed will tend to slide down to the inside of the banked section and a car traveling faster will tend to slide to the outside of the banked section. These characteristics are especially evident when the road surface is slippery, as when covered with ice. In this condition drivers will generally drive slower than the speed for which the curve was banked, with the result that the car may slide down toward the inside of the banked section. When a certain critical speed is exceeded the necessary friction to keep the car on the curve suddenly vanishes with the result that the car starts to skid.

Many drivers step on brakes from force of habit as soon as the skid starts and instead of stopping the skid this is likely to make it worse. Applying brakes creates an unstable rear-wheel condition, whereas use of the throttle produces a driving force at the rear wheels which has a steadying effect on the steering of a car. Even racing drivers who take every possible advantage of speed will slow down when going into a curve but will "gun" the motor as soon as the car is safely on the curve, accelerating rapidly as they leave the curve. The majority of accidents on curves are caused by entering the curve at an excessive rate of speed.

Effect of Rough Spots on Road Surfaces.—Rough spots or waviness on road surfaces will greatly reduce the available friction between the surface and the tires as the speed of the car is increased. Prof. Moyer pointed out that Sir Malcolm Campbell waited for weeks at Daytona Beach for a perfectly smooth surface because waves in this surface providing a variation of only 2 in. in 100 ft., and which could not be detected by the eye, was sufficient to lift his 6-ton car off the surface at speeds of about 250 miles per hour. Only when he drove his car on a perfectly flat lake of salt did he achieve his ambition of driving 300 miles an hour.

It is interesting to know that the "Bluebird" had large fins to help steer it and that at 300 miles an hour the friction was so great that it caused a blowout and burned up his tires. Campbell is the only man who has driven at a speed of over 200 miles per hour on a straight track, 500 ft. wide, without losing control of his car. Prof. Moyer said that high-speed runs of Campbell are important since they represent the ultimate possibilities in speed under ideal conditions. His runs were made with a very low factor of safety and they indicate possible factors of safety required for various driving conditions.

Ice Control at Milwaukee With Rock Salt

By CHAS. O. DAVIS

Superintendent of Streets and Sanitation

FOR more than 35 years the writer has been using salt for ice control in the city of Milwaukee. Last year more than 120 miles of streets were completely covered with a mixture of sand and salt, some of them as many as 20 times. As a result, traffic in Milwaukee has flowed with practically the same ease and safety through the winter as during the rest of the year.

Complete details of the procedure are outlined below:

Coarse sand is mixed with salt at the rate of 100 lb. of salt per ton of sand. Salt and sand are stocked at the highway garage in separate bins. Trucks are loaded by five men, four shoveling sand and one salt, the proper proportion being gauged by eye and checked in the field by the action of the mixture.

The salted sand is applied to the streets in two ways. First, by sand boxes located at critical points, such as intersections, hills, curves, etc. There are now about 500 sand boxes in use. Each box is kept full of mixed material, is supplied with a shovel and the box left unlocked. When the street becomes coated with ice, policemen, city employes, and even private citizens spread the mixture over the ice. Thus the critical points in the city are rendered nonskid within a few hours after the appearance of the ice at any time.

In addition to sand boxes, the mixture of salt and sand is spread on the whole surface of 120 miles of streets by means of dump trucks hauling an approved design of sand spreader. These spreaders are very effective and more economical than hand spreading. Each truck holds five tons of salted sand, travels at eight to nine miles per hour while spreading and will treat about two miles of street surface per load. Sand is spread to a width of about 20 ft., the five or more feet on each side being covered by material thrown out by passing automobiles and trucks. This small amount of salted sand, about one-twentieth pound of salt per square yard, is sufficient to render the ice non-skid and to reduce it to granular form, but is not sufficient to cause objectionable slush, dust or mud. Four trucks are employed on this work almost continually through the winter.

Loading the Spreader with the Salt-Sand Mixture

Spreader in Operation

CC* rock salt has been found in Milwaukee to be best adapted to this work. It flows freely in spreaders and loading spouts, and will not harden in bags or in storage as will the finer grades of rock salt. Consequently, it can be stored and easily handled in bulk. In case of emergency, it can be stored in the open without protection, and if so stored, will not harden or dissolve to an appreciable extent.

Coarse sand, up to pebbles passing a ¼ in. screen, is better than fine sand or cinders. Cinders crush under traffic and are easily blown away, necessitating frequent replacement. Also, property owners object to the resulting dust and dirt.

Untreated sand, cinders, or other abrasive are less economical than when mixed with salt because more frequent application is necessary due to the fact that in cold weather the salt causes the particles to melt themselves into the icy surface and to reduce the time required to break up and melt the ice.

*CC Grade passes through a No. 4 U. S. Standard screen and is retained on a No. 10.

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Public Works Highway Construction

The annual report for the fiscal year ending June 30, 1935, of Thomas H. MacDonald, Chief Bureau of Pulic Roads, contains the following: The Public Works highway program was initiated in June, 1933, and by June, 1935, the road construction totaled 24,600 miles. At the same time 8,529 miles were under construction and 1,427 miles had been approved for construction, a total of 34,556 miles. Of the mileage completed and under construction 17,341 miles were on the Federal-aid system, 2,413 miles on extensions of the system into and through cities and 13,376 miles were secondary or feeder roads.

The program also included special work-relief highway construction in areas in 10 states where distress was particularly acute because of drought and a scourge of grasshoppers. This work totaling 8,727 miles, has been financed by the Public Works Administration and the Federal Emergency Relief Administration, and construction has been supervised by the Bureau of Public Roads and the State highway departments.

Ice on Road Near Gulkana Roadhouse, Richardson Highway, Caused by Ice Run, May 9, 1933

WINTER PROBLEMS ON ALASKAN ROADS

By HAWLEY STERLING

Assistant Chief Engineer, Alaska Road Commission

USUALLY the first thought which flashes through the mind when the word "Alaska" is mentioned is one of snow, cold and glaciers. Alaska has all of these but not in the proportion with which it is generally credited.

There are, it is true, long spells of cold weather, a tremendous snowfall and gigantic glaciers—but only in certain localities. It seems hard to believe, but in some parts of this great country it never snows, the thermometer never reaches zero and glaciers are unknown or can be seen only on a clear day many miles distant. Temperatures, in places, do reach 70 degrees below zero and snow in other places sometimes reaches 15 ft. in depth, generally speaking this occurs in the United States proper as well.

There are approximately 2,400 miles of road in Alaska which can be traversed by automobile in the summer months, most of which are confined to small isolated systems connecting settlements with mining or other activities. The longest continuous piece of road stretches from Valdez on the coast to the Yukon River at Circle City, a distance of 533 miles. The portion from Valdez to Fairbanks is known as the Richardson Highway (370 miles), that from Fairbanks to Circle as the Steese Highway, 163 miles. This road, as well as practically all other Alaskan roads, is closed from about Oct. 10 to June 10.

Building a Shoo-fly to Avoid Drifts and Slides, 1934

Roads, generally, are not kept open during the winter, the principal reason being that there is no occasion for it. Most activities are carried on in summer exclusively and travel is usually very light even during the summer. Keeping long roads open in winter is not warranted. A total of less than 150 miles out of the 2,400 miles is kept cleared. This occurs in closely populated areas or where it is necessary to take children to school. In some of the area requiring winter maintenance, no snow falls as a usual thing until after Christmas.

Snow removal is carried on by the same types of equipment as used in the States; namely, rotary plows on trucks, and push or blade plows on tractors. For light work blade plows on trucks have been used.

Alaska does have some unusual problems in connection with roads resulting from winter conditions; that is, heavy ice runs in rivers, snow slides, glaciering of streams and glaciering of roads from surface seepage.

Ice Damage and Obstructions.—Ice runs ordinarily occur, of course, in the spring when the melting of snow has made enough water to raise the river ice and carry it away. The damage which may be expected depends upon the weather conditions during the winter

and at the time of the run; that is, the thickness of the ice, the amount of snowfall and the speed with which the water rises in the spring. A combination of light snowfall, mild winter and cool days in the spring causing slow run-off occasionally permits the ice to thaw without moving. The other extreme with heavy snowfall, preceded by very cold weather forming thick ice and followed in the spring with sudden increase in temperature is often disastrous to bridges and roads, carrying spans away bodily and floating great cakes of ice on to roads adjacent to the streams.

Freak river breakups have occurred in the dead of winter with temperatures 40 degrees below zero. This is caused by the accumulation of water during the summer in glacier lakes forming the source of rivers. An ice dam is formed at the outlet of the lake prohibiting the natural flow. If this is followed by a warm spell which may occur even though the valleys miles away may register 40 below, the ice dam breaks and the surplus accumulation in the lake comes down with a rush taking the river ice out with it.

Snow Slides.—Road locations are sometimes necessarily made in snow slide areas. Funds do not permit of installation of snow sheds. There are places where such slides are 50 ft. in depth when the balance of the road is entirely free of snow in the spring. This snow would remain during half the summer unless removed. Removal is done with bulldozers and small gas shovels with oversized buckets. Snowslide Gulch, a narrow ravine 15 miles from Valdez on the Richardson Highway, is completely filled with snow in May. Eventually, if funds permit, it is planned to construct a short concrete tunnel across this gulch with a smooth, cobbled apron extending up the gulch from the top of the tunnel to enable the snow and rocks to shoot over the tunnel and into a deep canyon just below. At another location where a heavy drift annually occurs along the shore of a shallow lake a short fill has been built in the lake around the toe of the drift. This narrow fill is used until such a time as the drift is dissipated by the sun.

How Ice Is Handled.—Bridge spans near the head of glacier streams have been completely buried in ice. This condition is brought about by the stream either freezing solid to the bottom or by the stream sealing over forcing the water to the surface and allowing ice to build up. Extreme conditions like these are caused by long cold spells before any snow falls. In order to open the road for summer travel and incidentally to save the bridges from breaking under the load it is necessary to remove the ice both from the deck, and from under the structure where it sometimes clings in heavy chunks,

Snowslide Gulch, May 20, 1935

Ice Over Four Span Bridge, Chitina District, June 8, 1935

the stream having opened from below. In one instance recently the deck was cleared by cutting the ice into huge blocks with a steampoint and boiler and dragging the blocks off with a tractor.

Not the least of winter troubles is glaciation caused from surface water and sometimes caused from subterranean waters building up under the ice and gradually freezing. This condition ordinarily occurs on hillsides, and because the ice builds up on the inside of the road it makes a treacherous slope for a car to negotiate. Except in rare instances this usually happens in the same place each winter, its extent depending upon weather. Most of these places could be handled by adequate underground drainage. Road funds have never been extensive enough to go into this phase of protection. Various means are used to allay surface glaciering such as trenching before freezeup between the road and the point where the glacier first appears and throwing brush into the path of the glacier above the road. Neither method stops the glaciering but will sometimes create a tendency for the glacier to form above the road rather than on it.

Successful underground drainage in at least one known case has been constructed previous to cold weather by digging a series of trenches about 4 ft. deep and 3 ft. wide into the glacier area, these trenches all leading into one which passed under the road through a covered opening or culvert. The trenches were partly filled with poles, followed by a layer of large bowlders or large broken rocks and the whole covered with a deep layer of moss which served as insulating material.

Compensations.—In conclusion, snow removal in Alaska in areas where roads exist and deep snow prevails is not a serious problem principally because no attempt is made except under unusual circumstances to remove the snow. In fact, snow-covered highways, sled roads and trails in remote regions adaptable to winter travel are decidedly an advantage as heavy freight is moved with tractors and sleds over long distances, some areas of which are entirely impassable in summer.

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PLACING SNOW FENCE—Whenever the velocity of the wind is checked it creates an eddy and causes the deposit of snow. A report of the U. S. Bureau of Public Roads states that the Michigan Engineering Experimental Station has reported that the distance to the end of the eddy varies with the height of fence, and for slat fence is about 15 times the height. A 4-ft. fence should, therefore, be placed at least 60 ft. beyond the outside edge of the ditch on the windward side of the road to prevent the toe of the drift from covering the ditch.

Making 103 Ft. Cut on Nisqually Highway

The Nisqually cut-off on the state highway between Olympia and Tacoma, Wash., will save 2.74 miles and reduce the degrees of curvature from 1060 degrees to 48 degrees.

There is one very interesting section in this cut-off, the construction of which was awarded to Contractor M. S. Ross, of Los Angeles and Grand Coulee. In addition to an extensive channeled change, it contains a cut with a maximum center line of 93 ft., maximum depth, at a knoll, of 103 ft., and a width at the top of 328 ft., with slopes of 1½ to 1. This required the excavation of 642,700 cu. yd. of unclassified material from the cut and transporting it out on the adjoining fill, the latter having a maximum center line of 89 ft. and a width at the base proper of 323 ft. The grade line has a rise of 6 per cent over the fill and through the cut. The work was completed about the first of October, 1935.

Shovels Working in Close Quarters at Top of Cut, Loading Trucks Which Transport Material to Head of the Chute by Means of Which It Passes to Trucks Below

This undertaking was of a magnitude not ordinarily encountered in highway work. The method employed was to build a chute down the side of the hill, as is frequently done in railroad construction practice. Then two Northwest 80 gas shovels were set to work on top of the hill, delivering to trucks. The latter dumped the material into the chute, down which it passed by gravity to trucks below, which took it out onto the fill. As the cut deepened, the chute was cut off at the top, and as the fill rose it was cut off at the bottom. Finally, it was done away with altogether, when the cut and fill grade lines had come near enough together so that a truck ramp could be built up from fill to cut. Practically all material handling was done by trucks of from 4 to 14 cu. yd. capacity.

Material Takes a Toboggan Ride Down the Chute to the Hoist Operated Gate Through Which It is Allowed to Escape, a Truckful at a Time. In This Case a Tractor Drawn Buggy Happened to Be There, But 4 to 14 yd. Trucks Did Most of the Work

The chute was built of 4 by 12's, 12 ft. wide and 4 ft. deep. It was lined with boiler plate and had a hoist operated gate at the lower end, permitting a truck load to be dumped at a time. The whole structure was supported on log piles. Total drop was 135 ft. and the slope was 1 to 1.

Far in the Distance Is the Chute, While Here Is the Fill Itself, Being Laid Down in 4 ft. Layers, Leveled by Caterpillar Bulldozers. This Fill Crosses a Channel Diversion Which Was a Considerable Part of the Contract

EDITORIALS

Road Show and Convention

THOSE in charge of arrangements for the road show at Cleveland Jan. 20 to 24 have twice had to add to the space originally provided. Nuff said. We'll see you there.

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Landscapes and Billboards

COMPARATIVELY little has been said of the inconsistency between billboards and highway beautification; and in most states the two flit side by side or in annoying sequence past the eye of the motorist.

That billboards are ugly will be denied by no one except those financially interested. That they are a menace to safety has been from time to time asserted but is not easy of proof except where they actually obstruct a view of the road at curves or intersections, and where beyond question, highway authorities should have power to remove them.

The inconsistency between billboards and landscape improvements should be apparent to anyone. Of what use is it to develop beautiful perspectives or graceful slopes or plantings of green shrubbery in the vicinity of a wood or metal sign which draws the eye by its size, sharp outline, and vivid color? It is silly to say that we need not look at the sign if we don't want to, for it is put there to be looked at, and its every feature is carefully designed to force attention. Every beauty of adjacent landscape is overwhelmed by its presence; while the distant scene too often is broken, marred, or actually obscured by it.

We all love beauty (though some, through fear of appearing soft, deny it) and the American people is coming rather fast to an intelligent appreciation of it. A few far-seeing corporations already have stopped their billboard advertising, and others undoubtedly will follow suit, but many will refuse to give up what they consider a good advertising medium. These latter should be restricted by law as far as can be done under the Constitution. They will, of course, complain that they are merely striving for an honest profit, but integrity of motive is not the issue. We are in an era where private interests are having to give way to public interest, and in this case there can be no question as to where the public interest lies.

The CCC and other relief organizations, as well as permanent state and county forces have done much to improve the appearance of our roadsides, and if such work is warranted as a public benefit, it seems clear that the removal of the signs is even better warranted, for they are the commonest and very nearly the grossest of landscape blots.

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Decentralization in New Jersey and Elsewhere

THE New Jersey State Planning Board, in its first annual report submitted to Governor Hoffman in November, points out that the state is suffering from over-concentration of population in badly organized metropolitan areas, and that a planned decentralization is necessary. This decentralization probably would involve the development of satellite cities and new rural-industrial communities, and would be induced to a considerable extent by the location and improvement of highways.

That much may be said for decentralization seems clear, but there are also strong forces operating against it, and it certainly is not going to come suddenly. The New Jersey report represents a highly intelligent approach to the problems, and its emphasis on roads is of obvious importance. The practical development of each such area depends on its means of communication with other points, including not only the great centers which it is intended to reduce but other areas similar to itself, areas supplying raw or semi-finished materials, areas supplying food and other necessaries, and recreational areas.

Such generalities apply equally to other states, and add promise to the long view of highway construction.

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Roads in Earth's Far Places

THE Dominican Republic, occupying considerably more than one-half the island of Haiti, and still one of our little known neighbors, has a total of about 1,200 miles of motor highways, practically all built within the past 20 years. The advent of these roads has already wrought changes in the lives of the inhabitants; not only by promoting education, trade and similar benefits, but in getting the people of one district acquainted with those of another in a way that the preceding 400 years of boat and trail communication could not do. And in developing acquaintance they are developing understanding, community of purpose, and all those things which make a strong people.

It is important to note also that the Dominican road system is now being well maintained and extended, although up to about 5 years ago there had been lack of adequate maintenance.

What is happening in this little country is being paralleled in varying degrees in other out-of-the-way spots, which fact should be worth noting by American manufacturers and producers. Highway development, once well started in these places, will gain momentum, and can be counted on to go a long way before losing impetus. An alert eye on the far places of the earth will bring profits.

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Inter-American Highway

AS the result of an allotment of $340,000 by President Roosevelt from the Inter-American Highway Fund, construction will be begun soon on three bridges in Central America—one over the Choluteca River in Honduras, another across Chiriqui Viejo River in Panama, and the third in Guatemala. Thus an important step will be taken in linking the northern and southern continents with a great thoroughfare which will lead to better acquaintance, better understanding, and much general benefit. This glorious and long-dreamed-of project may become a reality sooner than has been anticipated. Success to it!

NEW EQUIPMENT AND MATERIALS

New Vibrators for Placing and Compacting Concrete

A complete series of ten models of vibrators stated to suit any type of concrete work from road slabs to heavy mass concrete has been brought out by the Master Vibrator Co., Dayton, O. The diameter sizes are 2½ in., 3½ in., 4 in. and 6 in., and the power range is ½ HP., 1 HP., 1½ HP. and 2 HP.

The vibrators are built with floating power. The motor, fields, armature and leads are almost completely divorced from all vibration. The lower portion of the vibrator containing the rotating offset weight is insulated from the upper portion by a rubber seal. The bolts which join the two sections together have rubber insulated steel spacers. The drive connection from the motor has a moulded flexible rubber connection splined at both ends with the steel splines moulded into the rubber. These methods are claimed to transmit an absolute minimum of vibration to the motor, bearings, armature and leads. Also, there is no vibration transmitted to the hose leading away from the vibrator unit.

Master Two-High Speed Highway Type Vibrator

There are two methods of varying the frequency of vibration furnished with the vibrators. One method is an adjustable generator cycle when the vibrators are operated from a Master generator set. The second is by means of the built-in motor gear head. Vibrators One and Two include the Master automatic starting device, guaranteed good for 1,000,000 starts and stops. The vibrators are assembled and packed at the factory and it is claimed that lubrication is required only once in 6 months.

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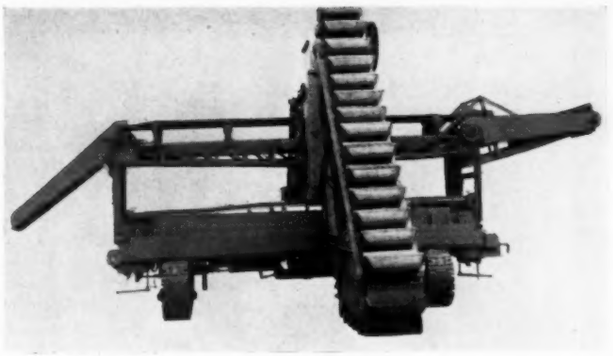
New Fine Grader

A new fine grader and shoulder machine has been developed by A. W. French, 8524 Vincennes Ave., Chicago, Ill., formerly of A. W. French & Company, Chicago, manufacturers of the Ord concrete finisher.

This machine, known as the French Utility Grader, is stated to complete the work of subgrading, formgrading, shoulder grading, stripping, leveling, and material loading without any material change to the machine.

The grader operates on its own crawler tracks, and so eliminates the use of road forms when cutting subgrade on road construction. It cuts an accurate grade to any crown or surface desired, the grade being controlled by a leveling frame which is adjusted to a line set from the engineer's grade stakes. It is claimed it can handle cuts up to 7 in. and on subgrade work cuts not only the subgrade but the formgrade at one passage of the machine. Material taken from the subgrade can be either loaded into trucks, for placing where needed, or spilled along the shoulder.



New French Utility Grader

The utility grader is built in but one size, cutting 13 ft. wide in one passage of the machine. When used on wider pavements, two or more passes are made, thus allowing trucks plenty of clearance to pass the grader on the way to the mixer.

The grader is completely power operated, with two gasoline engines furnishing the power. One operates the cutting elements and the other the traction, belt conveyor, etc. The feature of the machine is the principle of cutting with the buckets. It is stated that with the method employed, cuts of from 3 to 5 in. can be handled in very hard materials, at the same time leaving a grade which is accurate to within plus or minus ¼ in. of grade.

The machine has a complete range of speeds forward and reverse which are in accord with its cutting ability.

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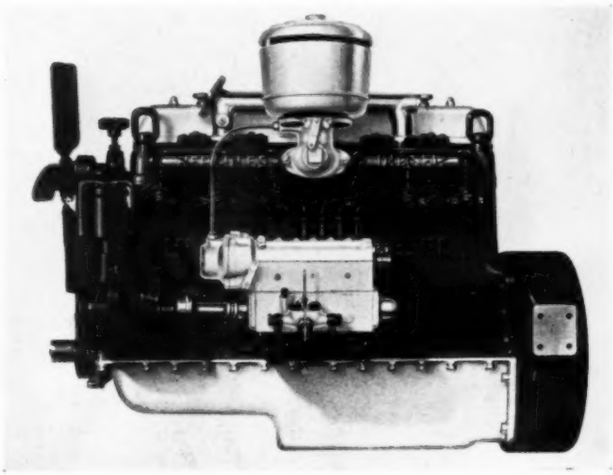
New Diesel Engines

As another step in their program to have available a complete line of high-speed 6-cylinder Diesel engines paralleling in performance and installation dimensions similar displacement Hercules gasoline engines, Hercules Motors Corporation of Canton, O., now announce the series "DJX" Diesels.

Both models in this series are 6-cylinder, the smallest, the "DJXB," having a 3½ in. bore and 4½ in. stroke, a 260 cu. in. displacement. The "DJXC" has a bore of 3 11/16 in. and 4½ in. stroke, with a 288 cu. in. displacement. On the dynamometer the "DJXB" is rated 79 H.P. and the "DJXC" 82.5 H.P. at an engine speed of 2,600 R.P.M.

This "DJX" series of Diesel engines are interchangeable from an installation standpoint with the extensively used Hercules "JX" series of gasoline engines—thus providing manufacturers the opportunity to supply either gasoline or Diesel engines in their equipment without any mounting complications. This fol-



"DJX" Diesel

lows the same practice which prevails in the two larger models of Hercules Diesel engines and the companion gasoline models.

The general design of the "DJX" series follows that developed by Hercules in their two larger Diesels, the "DHXB" 5x6 in. and "DRXB" 4⅜x5¼ in., including the patented auxiliary combustion chamber—which assures very complete combustion—controlling also the burning of the fuel, which results in smooth, powerful, flexible and economical performance. This pre-combustion chamber (an entirely American development, designed and patented by Hercules), is located at the side of the cylinder bore, and the "throat," which connects the cylinder with the chamber, is so designed that the piston on its approach to top center on the compression stroke gradually reduces the throat area, thus automatically increasing the velocity of air entering this chamber at the time fuel is injected, insuring very thorough mixing of fuel and air.

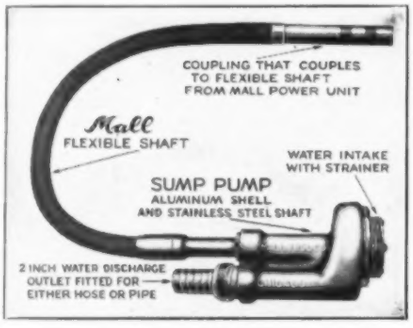
A very rigid crankshaft of ample proportions is supported by seven bearings in a crankcase which is cast integral with the cylinders, which crankcase also supports the four bearing camshaft.

New Sump Pump

The Mall sump pump is a new type being introduced by the Mall Tool Co., 7740 South Chicago Ave., Chicago, Ill., to widen the already numerous applications of its gasoline engine and electric motor power units.

This sump pump is a compact, rugged unit, constructed of non-corrosive materials. It is portable, easily carried by one man. It is designed for pumping out excavations, sumps, caissons, tunnels, trenches, manholes, tanks and coffers, and will pump clear or muddy water, sewage or oil with equal efficiency.

It is self-priming because the pump itself is submerged directly into the water being pumped. It is non-clogging and has a rated capacity of 4,500 gals. per hour against a 25 ft. head. Its 2 in. discharge opening can be fitted with either hose or pipe.



The Mall Sump Pump

It can be operated from any gasoline engine or electric set with vibrator shaft detail by simply coupling flexible shaft furnished with pump to flexible shaft used for vibrating.

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It can be operated from any gasoline engine or electric set with vibrator shaft detail by simply coupling flexible shaft furnished with pump to flexible shaft used for vibrating.

New Welders

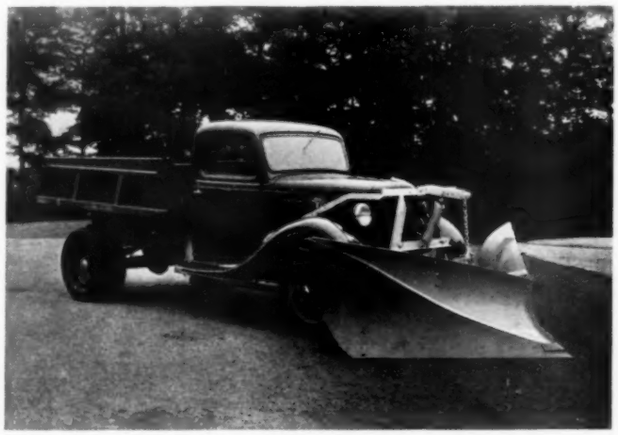
Radically improved in design, the new Flexarc d.c. welder recently announced by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., embodies many improvements. Equipped with a single dial preset control with which the welding current can be set to the exact number of amperes, this welder is able to maintain an absolutely constant arc in spite of speed changes of the driving motor caused by line fluctuations. Open circuit voltage, well below hazardous values, provides safety for the operator yet retains all the desirable arc characteristics usually associated with high open circuit voltage. The moment the arc is struck, the set adjusts itself immediately to the required present value.

The Flexarc welder is a sturdy, compact unit designed for general welding service or production work with bare, dust coated or heavy coated electrodes. The arc is extremely stable and adjusts itself automatically to varying conditions, producing strong, uniform welds equally well on thick or thin gauge metals.

The set is self-contained from the conduit box to the welding terminals. The outer sheel consists of two parts bolted together forming a sturdy rigid unit. A one-piece common shaft supported by two super sealed ball bearings carries the rotating parts. The new set eliminates the use of meters, exciter, rheostat, reactor, unnecessary pushbuttons, field discharge resistor, starter holding coil and the conventional underframe.

"Light Artillery War" on Snow

The accompanying illustration shows a plow of the Good Roads Machinery Corporation of Kennett Square, Pa., on a 1935 Ford V-8 dump truck. Plows of different types ranging in weight from 925 lb. to 1,200 lb. may be mounted on the Ford truck in such a way that no fabrication of the frame or other truck parts



Good Roads Plow Mounted on Ford V-8 Dump Truck

is necessary. An underframe method of attachment is used effecting an even distribution of the thrust load over the truck structure in such a way that no part is subjected to undue strain.

The plow shown here weighs 1,100 lb. and is of the V-type. Other light plow models are of the reversible blade type which are used to displace the snow either to the right or left, the blade being adjusted as desired.

Sand Spreader

A compact sand spreader that operates entirely independently of the road surface for its drive has been placed on the market by the Anderson Engineering Co., Statler Bldg., Boston, Mass. The spreader is entirely suspended from the truck and spreads at any speed of the truck. The distributing disc remains in horizontal position with truck body at any angle obtainable. All gears of the spreader are enclosed and operate in oil bath. There are no bearings to lubricate.

Anderson Spreader Without Platform, Attached to Truck of Massachusetts Department of Public Works

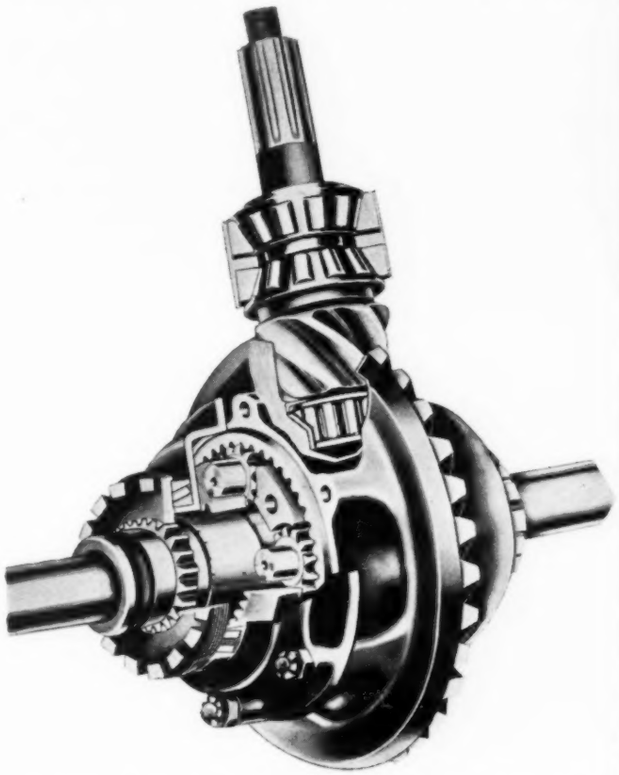
New Two-Speed Axle Trucks

International Harvester Co., 606 South Michigan Ave., Chicago, has announced the addition of three new models to its line of motor trucks, each of which features two-speed axle construction providing eight forward and two reverse speeds. With this construction all the advantages offered by both the high-speed and low-speed axle ratios are combined in one unit. The new models are the CS-30, CS-35 and CS-35-T.

This two-speed rear axle is available in both the 5.14 to 1-7.15 to 1 and the 6.16 to 1-8.57 to 1 axle ratios.

The Model CS-30 is available in two wheelbases—133 and 157 in., while the Model CS-35 is offered in 136, 160 and 175 in. wheelbases. The 6-wheeler Model CS-35-T is built in two wheelbases—168 and 180 in.

All of these models are powered by 6-cylinder engines of International Harvester design and manufacture. The Model CS-30 engine is of the L-head type with dome-type combustion chambers. At 3400 r.p.m. this engine develops 78.5 brake horsepower with a maximum torque of 151 pound-feet at 800 to 1400 r.p.m. Bore and stroke are 3 5/16 to 4⅛ in. respectively. The



Cutaway View of the International Two-Speed Rear Axle. This Shows the Four Planetary Gears in the Unlocked or Low-Speed Position

clutch is of the single-plate type with built-in vibration damper, and the transmission has four speeds forward and one reverse, giving a total of eight forward and two reverse speeds when employing the two ranges of the rear axle.

The Model CS-35 power plant is of the valve-in-head type with replaceable cylinders. Bore and stroke are 3 7/16 and 4 in. respectively. This heavy-duty truck power plant develops 160 pound-feet torque at 800 to 1500 r.p.m. and a maximum brake horsepower of 78 at 3400 r.p.m. The same engine is employed in the 6-wheel Model CS-35-T.

Transmissions in the CS-35 and CS-35-T have four forward speeds and one reverse and are equipped with five anti-friction bearings. Clutches are of the single-plate type with built-in vibration dampers and both clutches and transmissions have unusually great torque capacities.

The International dual-performance axle consists of a straddle-mounted spiral-bevel drive pinion, a differential carrier assembly

mounted on roller bearings, full-floating axle drive shafts, and the shifting mechanism, fully enclosed in a rigid one-piece cast banjo-type housing. The differential carrier assembly incorporates a spiral-bevel ring gear, a simple supplementary planetary reduction gear set (the low-speed feature), and the usual four-pinion differential unit.

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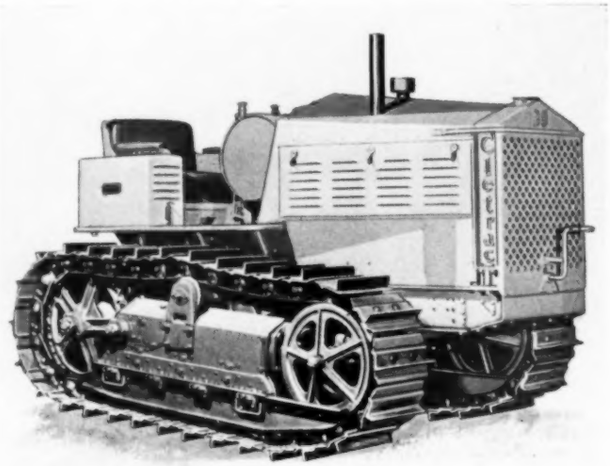
New Model "30" Cletrac

The new model "30" Cletrac has been announced by the Cleveland Tractor Co., Cleveland, O. This model develops 33 horsepower at the drawbar and 38 belt horsepower. The power unit is a 6-cylinder, 3¾x4¼ engine, with forced-feed lubrication to



New Model "30" Cletrac

the crank-shaft connecting rods and timing gears. Six-volt starting and ignition units are standard equipment. There are three speeds forward—1.75, 2.75 and 4.25 m.p.h. Steering is by the Cletrac controlled differential.

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WITH THE MANUFACTURERS

Atlas Equipment Corp. Now Distributors for Lorain Power Shovels

The Thew Shovel Co. and the Universal Crane Co., Lorain, O., announce the appointment of the Atlas Equipment Co., 1447 Oliver Bldg., Pittsburgh, Pa., as exclusive distributors for Lorain power shovels, cranes and draglines, in capacities of ⅜ yd. to 2 yd., in western Pennsylvania and adjoining portions of West Virginia and Maryland. The principals of the Atlas Equipment Corp. are Paul B. Reinhold, president; J. L. Baird, vice president; L. B. Cummins, secretary, and H. A. Ward, all well known in the construction field in this territory.

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Western Material Co. Appointed Distributor for Rex Equipment

The Chain Belt Co., Milwaukee, Wis., has announced the appointment of the Western Material Co. at Sioux Falls, S. D., as an exclusive distributor for Rex equipment in the state of South Dakota. The Western Material Co. was established in 1922 and during the past 13 years they have been serving the contractors in the South Dakota territory. Mr. E. K. Hurst, President of the Company, has been identified with the construction machinery industry for many years as has his force of salesmen and service mechanics. The Rex line of construction equipment which will be handled by the Western Material Co. consists of building mixers in sizes ranging from the 3½-S to the big 84-S; the 27-E paver; Rex plaster and mortar mixers; Rex saw rigs; Rex cold patch mixers; Rex speed prime and diaphragm pumps; and the Rex pumpcrete (the pump that pumps concrete).

Link-Belt Executive Offices Move

The executive offices of Link-Belt Co., for many years located at 910 S. Michigan Ave., Chicago, have been moved to the Bell Bldg., 307 N. Michigan Ave., where they will occupy the entire 23rd floor, and the north half of the 21st floor.

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New Appointments by Republic Steel Corporation

N. J. Clark, Vice President in charge of sales for Republic Steel Corporation, Youngstown, O., has announced the following appointment: Robert J. Working has been appointed District Sales Manager in the Birmingham, Ala., territory, succeeding Kenneth D. Mann who has resigned to became Executive Vice President of Truscon Steel Co. Paul R. Johnston has been named District Sales Manager in the Cincinnati, O., territory, succeeding Robert J. Working, recently appointed District Sales Manager at Birmingham, Ala. Charles W. East, formerly of the Birmingham, Ala., office, has been named Assistant Manager of Sales in Republic's Pipe Division, succeeding George E. Clifford, recently appointed District Sales Manager for Republic in the Los Angeles, Calif., territory.

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H. M. Daniels New Eastern Sales Supervisor for FWD

Appointment has been announced by R. H. Schmidt, general sales manager of the Four Wheel Drive Auto Co., Clintonville, Wis., of H. M. Daniels as supervisor of the new consolidated eastern sales division and A. F. Waterland as manager of the newly established Philadelphia Branch. Daniels, the new eastern sales supervisor, has been manager of the New York Branch for over twelve years. Prior to that, he was foreign sales representative in China, Java, and the Far East. Daniels celebrated the acceptance of his new post with closing of an order with New York City for twelve hook and ladder trucks and twenty, six ton capacity, combination wrecking and snow removal trucks. Waterland brings to his new post over ten years successful experience in the foreign and domestic sales of FWD (four-wheel-drive) trucks. For eight years he was foreign sales representative in Mexico, Central American countries and England. Prior to his new appointment he was district sales representative with headquarters at Harrisburg, Pennsylvania.

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Federal Holds Silver Anniversary Convention

Federal Motor Truck Co. dealers and their salesmen from all parts of the country assembled in Detroit Nov. 11-12-13 for the company's silver anniversary convention which was featured by the introduction of the new Federal ¾ 1-ton truck for 1936 and the launching of the Red Circle Club—an entirely new retail sales activity. Martin L. Pulcher, President of the Federal Motor Truck Co. presided personally over the mechanical meetings held at the Federal factory and J. F. Bowman, Vice-President in Charge of Sales, supervised the marketing and sales sessions which were held both at the factory and at convention headquarters in one of Detroit's downtown hotels. Assisting Mr. Pulcher in the mechanical sessions were members of Federal's engineering staff as well as other engineers well-known in the automotive field. In addition to an intensive discussion of Federal's new ¾ 1-ton truck, the entire Federal line of trucks for 1936 was analyzed. A high-spot of the convention was the silver anniversary banquet given to Federal dealers and their salesmen by the company, commemorating the successful completion of 25 years of Federal trucks. This occasion likewise marked the 25th consecutive year during which Martin L. Pulcher has served as directing head of Federal Motor Truck Co.

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Gale Appointed Assistant District Sales Manager for Pennsylvania-Dixie Cement

The Pennsylvania-Dixie Cement Corporation announce the appointment of Erie L. Gale as assistant district sales manager for the territory served by the Des Moines plant. His headquarters will be in the Old Colony Bldg., Des Moines, Ia. Mr. Gale's experience in the cement industry extends over a period of 25 years and he has an extensive acquaintance in building supply and construction circles.

Keith Evans Appointed Manager Sales Promotion Division of Inland Steel

Keith J. Evans has been appointed Manager of the Sales Promotion Division of Inland Steel Co. Mr. Evans will be in charge of the company's advertising, sales statistics and commercial research. He has served in a similar capacity with Joseph T. Ryerson & Son, Inc., since 1917, and will continue to do so in addition to his new position with Inland Steel Co. He will have offices at both establishments. Mr. Evans was employed by the C. B. & Q. R. R. Co. in 1910, and went to the Ryerson Company in 1912, becoming advertising manager in 1917. He served continuously with that company, with the exception of a brief absence during the war, when he served as a lieutenant in the field artillery. Mr. Evans has won a number of awards in connection with advertising activities and has held many positions in advertising associations. He was President of Engineering Advertisers Association in 1920, founder and first President of the National Industrial Advertisers Association 1922, and at present, a member of the Board of Governors of the Chicago Federated Advertising Club.

Morton Now Branch Manager of FWD

R. H. Schmidt, General Sales Manager of the Four Wheel Drive Auto Company, Clintonville, Wis., has announced the appointment of H. W. Morton as manager of the Harrisburg, Pa., branch. Morton has been connected with the FWD Company for over eleven years. Prior to his new appointment he has held respectively the positions of manager of the parts department and assistant to the manager of the branch division.

R. M. Soper Now in Charge fo Road Department Standard Steel Works

R. M. Soper has been placed in charge of the road and street department and the tar kettle department of the Standard Steel Works, Kansas City, Mo. This department is being enlarged so as to handle a complete line of road oiling and bituminous heating and spraying equipment. The present line will include distributor tanks of all sizes of both the 2-wheel and 4-wheel type, tar kettles, shoulder rollers, 1 to 3-ton gasoline rollers, supply tanks, asphalt pumping equipment, power air spray units, chat spreaders, etc.

10,000th "Caterpillar" Diesel Leaves Assembly Line

Wednesday, Nov. 13, was a day of celebration at Caterpillar Tractor Co. plant, Peoria, Ill. At 11 o'clock that morning, smiling officials and plant workmen gathered at the end of one of the Diesel tractor assembly lines to greet "Caterpillar" Diesel No. 10,000.

Heading the group was President B. C. Heacock, and his smile was perhaps the broadest of all as he inspected the tractor, tested the controls and examined the numbered tag. The ceremony, however, was impromptu and brief, as Diesel No. 10,000 was pushing ahead, eager to join its fellows.

To emphasize the growing importance of the Diesel in the power world, the company, which announced its first Diesel tractor Aug. 31, 1931, presents the following figures on its Diesel engine production:

First Diesel model announced Aug. 31, 1931.
1,000th Diesel model built Sept. 23, 1933.
2,000th Diesel model built Jan. 16, 1934.
3,000th Diesel model built April 4, 1934.
4,000th Diesel model built Aug. 1, 1934.
5,000th Diesel model built Nov. 5, 1934.
6,000th Diesel model built Feb. 4, 1935.
7,000th Diesel model built May 6, 1935.
8,000th Diesel model built July 11,1935.
9,000th Diesel model built Sept. 16, 1935.
10,000th Diesel model built Nov. 13, 1935.

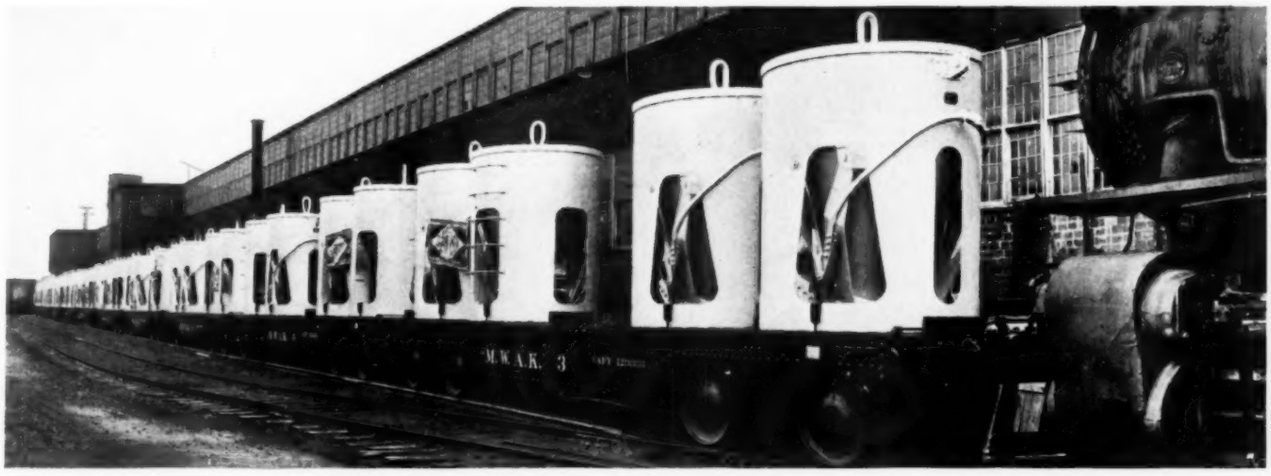
To summarize, "Caterpillar" has produced approximately as many Diesel engines during the past 12 months as it did during its first three years of Diesel manufacture. In the four years, it has produced 640,450 Diesel horsepower. Net sales reported by the company for the first nine months of 1934 were $18,669,315.55, and for the same period this year, $27,626,949.65, or an increase for the 1935 period of 48 per cent. So far, this year, the company's Diesel production shows a 30 per cent gain over its 1934 figure.

Concrete Buckets for Grand Coulee Dam Job

A train load of 40 Blaw-Knox roller gate concrete buckets for the Mason-Walsh-Atkinson-Kier Co., for use on the Grand Coulee Dam job, in the state of Washington, is shown in the illustration. These buckets have a rated capacity of 4 cu. yd. each (125 cu. ft. water level capacity) to handle low slump "mass" concrete. They weigh approximately 4,100 lb. each. In operation the special cars carry five buckets and are loaded at the mixing plant, then transferred by dinky locomotives over a trestle where Whirley cranes pick up the buckets and lower them to a position for dumping in the forms. These buckets are of the frictionless roller gate type, designed with sufficiently steep sides, walls and large openings for handling concrete as stiff as 1¼ in. slump.

Death of E. W. Rice, Jr.

Edwin Wilbur Rice, Jr., 73, honorary chairman of the board of directors of the General Electric Co., died at his home in Schenectady, N. Y., Nov. 25 after a long illness. He was one of the pioneers of electrical development in the United States, and in association with the late Charles A. Coffin played a conspicuous part in the building of General Electric. He was largely instrumental in adding to the company's technical staff the late Charles P. Steinmetz; he encouraged the investigation by the company of the Curtis steam turbine and gave it a fair trial through a period of uncertainty until it became the foundation of a vast electric power system development; and he was chiefly responsible for the establishment of the famous General Electric research laboratory, having recommended that step to the directors in 1900.



40 Blaw-Knox Roller Gate Concrete Buckets for Use in Constructing the Grand Coulee Dam in Washington

Born in La Crosse, Wis., on May 6, 1862, he moved to Philadelphia where, as a school boy in 1876, he came into contact with Professor Elihu Thomson, then a teacher in Boys' Central High School. His natural fondness for mechanics and later for electricity was quickly developed by this association, and when, in 1880, the professor gave up teaching to go into electrical manufacturing, as scientist and inventor, young Rice gladly accepted an opportunity to become his assistant. He went to New Britain, Conn., and for three years was with Thomson in the American Electric Co. there and in Philadelphia, engaged in the manufacture of arc lamps and dynamos. In 1883 he went with the professor to Lynn, Mass., upon the organization of the Thomson-Houston Co., when a majority interest of the American Electric Co. was purchased by the former concern. At the age of 22 he was made plant superintendent and had this full responsibility until the consolidation of Thomson-Houston and Edison General Electric in 1892 to form the present General Electric Co.

In the new company Mr. Rice was first made technical director, and in 1896 vice president in charge of manufacturing and engineering. He eventually became senior vice president and in 1913 he succeeded Mr. Coffin as president of the company. In 1922, after nine years of service in that office, he was succeeded by Gerard Swope, and was made honorary chairman of the board.

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New Booklet Answers Diesel Questions

Couched in a simple, direct way and avoiding technical discussion throughout, a new rotogravure booklet, the "Whys and Hows of Diesel Engines," has just been issued by Caterpillar Tractor Co. of Peoria, Ill. Principal topics are headed, "Why the Diesel?", "How Does the Diesel Run?" and "What Do Owners Think?" The cover reproduces photographs of a Diesel tractor, stream-lined trains and a Diesel-powered submarine, and the text is interspersed with illustrations. Copies may be obtained from the company's distributors, agricultural dealers or by writing directly to the company.

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New Herringbone Gear Reducer Catalog

A new 32-page catalog, No. 1519, has been completed by Link-Belt Co., Philadelphia, on its line of single, double and triple reduction herringbone-gear speed reducers for large speed ratios and heavy and shock loads. Particularly stressed is the company's "RC" double-reduction reducer, which is made up of a herringbone-gear first reduction unit, and a finished-steel roller chain drive for the second reduction. Numerous example installations are sketched, with definite solutions of actual driving problems, to show the flexibility and relative advantages of this form of double-reduction unit. Another feature of the book is that it rates all reducers on the basis of the recently recommended practice of the American Gear Manufacturers Association, the company having re-rated its entire line to so conform. Service factors, dimensions and weights are given. A copy of new book can be obtained from Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia.

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Hoists—to Speed Production

Many money saving applications of the Sullivan utility hoists are suggested in Bulletin 76-X, a 12-page 2-color book just issued. These compact yet powerful hoists handle materials lifting on construction jobs, assembling cars, decking legs, timbering mines, trimming coal piles. Single and double drum types. Electric and compressed air drive. Simple operation, convenient controls, ample safety. Ask for bulletin 76-X, Sullivan Machinery Co., 1600-A Bell Bldg., Chicago, Ill.

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New Handbook on Sectional Plate Pipe and Arches

A new, up-to-date handbook for engineers on sectional plate and pipe and arch construction has just been released by the Toncan Culvert Manufacturers' Association, Youngstown, O. This handbook thoroughly covers sectional plate pipe and arch construction, along with informative tables and drawings pertaining to sectional plate pipe and arch installation.